POWER

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"Personally Conducted"

IF WE WERE going on a sight-seeing tour with an expert and experienced guide, we would certainly expect to see and learn more in a shorter time than we could discover for ourselves. However, under such circumstances, it would be essential that our guide should talk a language that we could understand, else an interpreter would be necessary.

In plant operation does not much the same condition prevail? Is it not expected that the boiler-room foreman should know more of the business than any fireman and that he should talk the fireman's language? Does not the chief engineer usually possess more intimate knowledge of every machine than any of his subordinates, and is he not expected to be able to converse in terms that they will clearly understand?

Yet, despite these obvious relationships, so obvious that their discussion seems almost absurd, are not many plants operated by management officials who neither understand nor sympathize with the needs of those whose affairs they must direct?

Is there any excuse for such managers? What right has such a manager to expect intelligent understanding of his instructions when he does not take pains himself to know and speak the language of his assistants?

It would, of course, be absurd to insist that the manager must know how best to swing the shovel in the fireroom, adjust the engine valves with the finish of the master engineer or manage switchboard detail like an expert electrician. If he took time and trouble to do all this, he would have no time for learning the problems and caring for the responsibilities of his own job. But, lacking in detail as he may be, there is no excuse for his lack of sympathy with his subordinates. He should listen attentively to them, study their proposals carefully, pass intelligently upon their needs as they are laid before him; then it will be certain that cordial co-operation will exist between operating force and management. The human relationships will be cordial and pleasant. The guidance of the superior will be welcomed. Without such relationship there will be only friction and misunderstanding, as with the guide who speaks a strange tongue. Indeed, "personally conducted" can be made to mean as much for business as for pleasure tours.

Testing Condenser Apparatus

How Commercial Tests Are Made on Ejectors, Circulating and Condensate Pumps

By R. N. EHRHART*

APPLICATIONS of condensers are so varied that an intimate knowledge of the performance of the apparatus is essential for the ultimate success of such applications. Therefore, the manufacturer who desires to serve his customer best, resorts to a thorough and rigid testing of his apparatus under conditions closely approximating those that will exist in service.

Condensing apparatus generally involves the test of two classes of pumps—those for handling air and those for handling water. In the case of surface condensers the bulk of the air gets into the system by infiltration or leakage; where jet or barometric condensers are used, the air comes from the condensing water. There is also the testing of ejectors, which is a comparatively simple

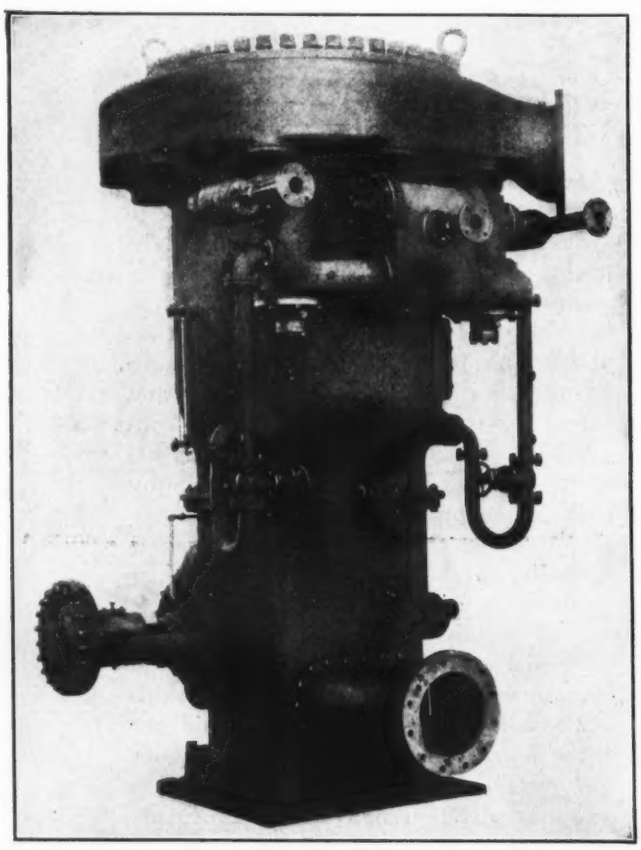

FIG. 1. JET CONDENSERS WITH TWO-STAGE EJECTORS AND INTER-CONDENSER

procedure. They are standardized in various sizes, and each size has a definite capacity for compressing air under specified conditions. The test, therefore, resolves into determining whether the particular ejector will compress a given amount of air from the pressures corresponding to certain vacua up to a pressure approximately one or two pounds above that of the atmosphere with specified steam pressures and quantities.

Measurement of the quantity of air handled can be easily made. The flow of air from one pressure to another through well-designed orifices has been so carefully investigated that it is safe to say that with given pressures the flow can be predicted through a certain orifice within 2 per cent of accuracy. Usually, no actual

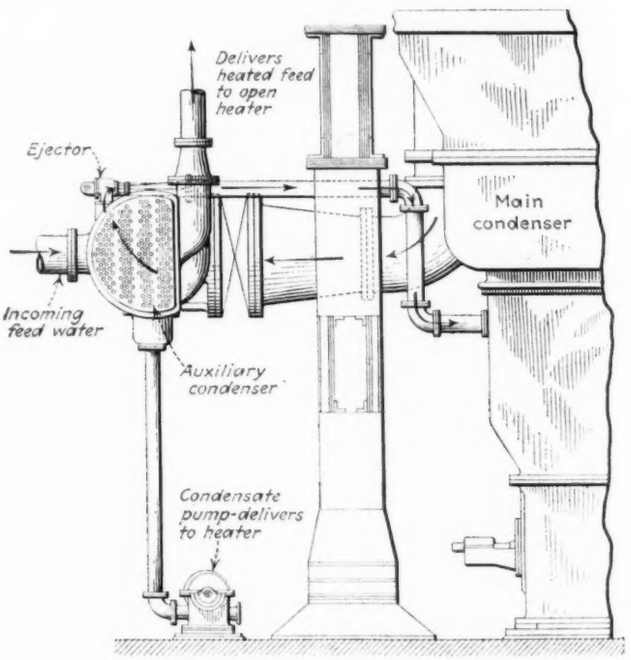

FIG. 2. HOW THE HEATER CONDENSES

measurements of steam consumption are made unless extreme accuracy is required, but the ejector nozzles are subjected to the closest micrometric inspection as to the dimensions of steam nozzles. The flow of steam may be calculated from the nozzle dimensions within one per cent of the actual flow.

Commercial tests on ejectors are usually made by admitting air direct from the atmosphere through the orifices to the suction of the ejectors, so that these tests show the performance with substantially dry air. When in actual operation in connection with a condenser, the air will be accompanied by vapor. It is therefore desirable that the manufacturer take the first ejector of a given type or design and submit it to a thorough test when handling mixtures of air and vapor. Once its charactristics are determined, dry-air tests alone will be sufficient for further commercial tests on duplicate ejectors. Fig. 1 shows a jet condenser, equipped with two-stage ejector with inter-condenser between the stages.

It sometimes happens that ejectors are used for special purposes or under unusual conditions. Ejectors are sometimes required to compress over a range entirely different from that from condenser vacuum to atmospheric pressure, as represented by a recent installation of a surface-condensing unit to operate in parallel with a large jet condenser.

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The jet condenser is located in a district where the water conditions are so adverse that surface-condenser tubes corrode quickly, so that jet condensers alone are usable. No advantage can be taken of the fact that the water passing through the condenser is heated approximately 20 deg., as the character of the water is such that it is not fit for boiler feed. The city water supply which is used for boiler feed is approximately 10 deg. colder than the injection water for the condenser, so that the water leaves the jet condenser approximately 30 deg. hotter than the water supply available for the boiler.

In one installation city water is used as the circulating medium through a surface condenser and is raised

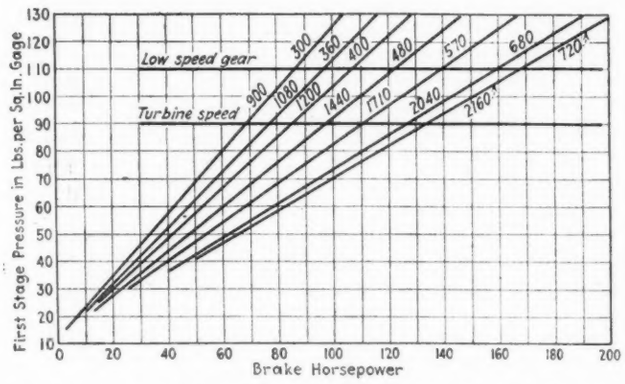


FIG. 3. CURVES PERTAINING TO VARIOUS PUMP SPEEDS AND HORSEPOWER DEVELOPED

in temperature approximately 30 deg., thus recovering an amount of heat roughly equal to 3 per cent of that fed to the main turbine and slightly increasing the overall vacuum, because the heater surface condenser is an addition to the total condensing capacity. The method of installing this heater condenser is shown in Fig. 2. It will be seen that the steam ejector does not deliver to the atmosphere, but back to the jet condenser in close proximity to the air-pump suction connection, so that this ejector merely has to have enough exhausting capacity to cause a positive flow from the main condenser through the auxiliary heater condenser. The range of pressure that this ejector will have to handle is probably not materially in excess of ½ in. of mercury.

Testing of such special ejectors requires the use of a fairly large condenser to which the ejector discharges. The condenser maintains a vacuum similar to that to be obtained in service, so that the ejector simply has to compress from a high vacuum created at its inlet to a slightly lower vacuum at the discharge. In this particular case it was necessary to use a jet condenser of substantially 2,000 kw. capacity to assist in the test of a special ejector, using but 550 lb. of steam per hour. This ejector, when compressing up to a pressure of 1 in. absolute, was able to maintain a pressure on its suction side within 0.05 in. of the barometer.

The testing of centrifugal pumps for small condensers presents no particular difficulty, but the quantity of water for large units is so huge that all the methods practical for small pumps are not practical for large sizes. Measurement of the quantity of water delivered by small pumps can be made by timing the filling of a tank of known capacity, by means of a weir box or by means of a venturi meter.

The venturi-meter method seems to be the most practical of applications for large pumps. A condenser pump delivering 20,000 gal. per. min. would require a large displacement tank for testing, and the piping and valves would be so cumbersome as to rule this method out. The weir method represents such absorption of valuable shop space that it is not generally considered. The writer's experience indicates that the venturi-meter method of test is accurate to within 2 per cent.

The testing of pumps resolves into measurements of a pump's ability to discharge the required amount of water against a specified pressure, not to exceed a certain power consumption. The measurement of water quantity as pointed out, is most easily made by means of the venturi meter, while the pressures may be accurately determined by the use of calibration gages and manometers.

The Elliott Company has adopted the calibrated turbine method of determining the power consumption of the pumps under test. If a turbine is operating at a certain speed and back pressure, it will be found that definite steam pressures at the first stage of the turbine exist for definite loads in brake horsepower. By subjecting turbines used for pump testing to a brake test, it is easy to establish a set of curves pertaining to various pump speeds so that at any of the given speeds it is only necessary to know accurately the first stage pressure in the turbine to know correspondingly the horsepower developed. Fig. 3 shows such a set of curves, and Fig. 4 shows a condenser that has been arranged for such a test.

It is sometimes necessary to make shop tests under unusual conditions on circulating pumps as well as on ejectors. A good example of this is the case of a circulating pump for a surface condenser receiving its

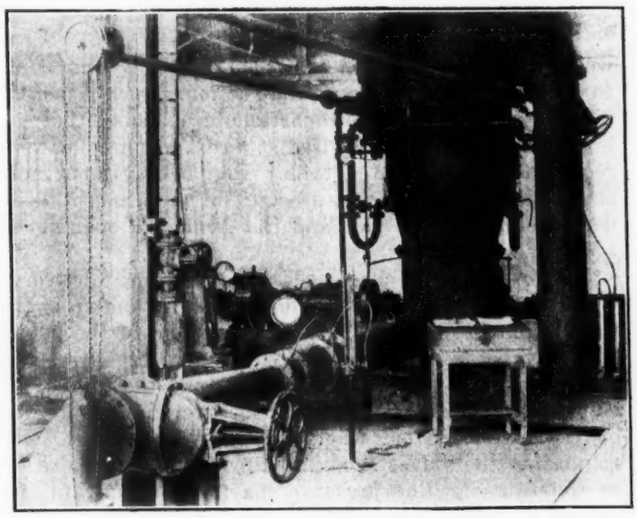


FIG. 4. CONDENSER ARRANGED FOR A TEST

water from a cooling tower located on the roof of the power plant. A circulating pump so operated will have a materially different characteristic as compared with its operation when installed under the usual condition of having a suction lift of, say, 10 to 15 ft. The capacity of a centrifugal pump of conventional design is generally increased when its inlet is under pressure. The amount of increase can be calculated, but a manufacturing company, to be in line with a thorough test policy, should subject to test pumps that are to operate under

unusual conditions even though it involves considerable expense.

The particular test under discussion involved the maintenance of approximately 50 ft. of head on the pump suction inasmuch as the cooling-tower basin was about this distance above the inlet of the pump.

It would at first seem necessary, in order to duplicate the field operating conditions, that an elevated tank

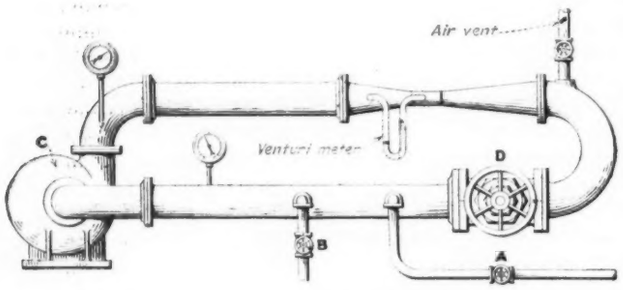


FIG. 5. ARRANGEMENT FOR TESTING PUMP

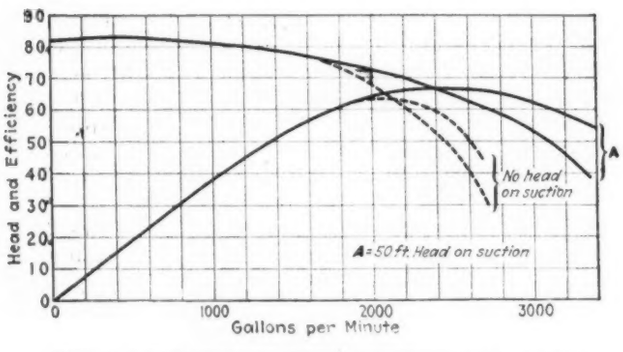


FIG. 6. TEST CURVES FROM CENTRIFUGAL PUMP

would have to be placed about 50 ft. above the pump to get the required head on the suction. Such a method would result in a disproportionate expense, but an ingenious method was devised at a cost much below that required by an elevated tank. Fig. 5 diagramatically shows the method of test used. The pump has its suction opening on the side and the discharge opening on top.

Water flows in a closed circuit, being delivered through the venturi meter from the pump and from the discharge of the meter back to the suction of the pump. The valve *A* is in a line connected to the high-pressure city service. If the valve *A* is open and the discharge-vent valve *B* is closed, full city pressure will be obtained on the water system when the pump is at rest. By regulating the valves *A* and *B*, any desired pressure up to the full city line pressure may be obtained in the system of piping. The valves *A* and *B* may be regulated so that the pressure on the suction of the pump *C* is maintained at the desired equivalent of 50 ft. head. If the pump is brought up to speed, it will add its pressure to that of the suction, so that we will then have one point on the characteristic curve of the pump performance. By adjusting the valve *D* the quantity of water circulated can be varied with coincident changes in pressure developed by the pump. In other words, by this method of testing it is possible to establish the complete pump characteristic with any desired head on the suction. Fig. 6 shows some of the data obtained during the tests.

A condensate pump is usually placed but a small distance below the surface condenser from which it must abstract the condensed steam. It must, therefore, operate with little submergence; that is, it must not permit the condensate to accumulate to such an extent that it will submerge any of the condenser tubes. It must also evacuate from a high vacuum and deliver against a specified head. These pumps are tested under conditions practically duplicating those that will be encountered in service. The test apparatus is shown in Fig. 7. *E* is a receiver, corresponding to the hotwell of a condenser equipped with a gage glass to indicate the water level. *F* is a steam ejector to establish a vacuum in the receiver corresponding to the vacuum existing in the hotwell of the condenser.

The pump is driven by a calibrated steam turbine for indicating the power consumed. The amount of water may be measured in the most convenient way. Tests are usually made over the whole range of capacity and head. It is important that the steam ejector shall maintain a vacuum corresponding to the temperature of the water fed to the receiver *E;* otherwise, the indicated capacity of a pump may be greater than that which will actually be obtained in service.

As already pointed out, the testing of condenser product involves the handling of tremendous amounts of water, therefore a pit or reservoir of considerable

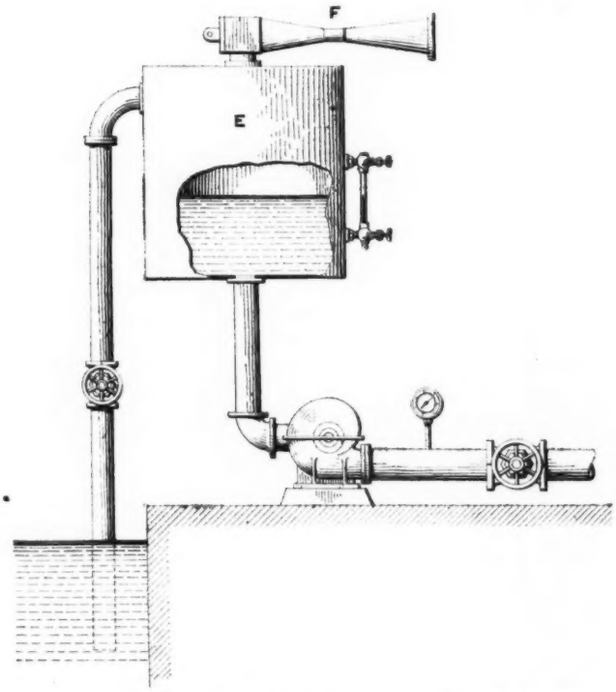


FIG. 7. PIPING OF TEST APPARATUS

size is necessary, which, however, may be located below the shop-floor level and covered over so that practically the whole space above it is available for setting the product to be tested. Water for the pump is taken from the reservoir and discharged back thereto after having passed through the venturi meter.

It is poor policy to attempt to use packing in an ammonia compressor after it has become hard and lost its resiliency. It will wear the rod and waste the ammonia.

Common Faults in Boiler-Plant Design

By GEORGE C. COOK

PROBABLY one of the most frequent faults in the design of power plants is the failure to provide sufficient space. This results in a crowded condition, which is a decided handicap in operating a power plant. It seems that the amount of working space in the boiler room must look larger on the plans than it does in actuality. The writer has never seen a plant with too much space allowed; the majority of plants have insufficient space for proper handling.

Space should be provided in front of the boilers for the easy removal of any tube, for the handling of material, removal of stokers, etc. The writer knows of a large hand-fired plant where, in order to remove a damaged boiler tube, it was necessary to cut a hole in the building wall opposite the boiler front.

The side aisles of the boilers should be wide enough to allow for the passage of material and for making repairs to the setting. Where a steam lance is used for blowing soot, the aisle should be wide enough to admit of using a lance sufficiently long to reach all parts of the tube surface, and, with stoker-fired boilers, to admit of the use of bars through the side inspection door for breaking clinker.

All parts of the boiler room should be well lighted and ventilated. The matter of providing plenty of space, proper lighting and adequate ventilation is one which directly affects the morale of the operating force; it is necessary to make such provision in order to obtain men of the higher grade of intelligence and reliability.

Valves Should be Accessible

Special attention should be given in the design to the matter of accessibility. Valves should be so placed that they can be reached easily in times of emergency and be located quickly even when the room is filled with steam or smoke. The arrangement of walkways and ladders should be carefully planned in such a manner that the piping does not interfere with their use. Overhead valves that are in frequent use should be provided with chains or extension stems so that they may be operated from the floor. Boilers should be provided with clean-out or inspection doors so placed that all parts of the interior can be reached.

In arranging the lighting, good general illumination should be provided as well as lighting at particular points such as at water glasses, gages, valves, etc. Wiring should be in rigid metal conduit, and outlets should be provided at convenient points for the attachment of lamp cords, electric drills and other portable electrical equipment.

Combustion is a chemical process, the reaction of two substances, fuel and air. As in all chemical processes, it is necessary for success that the reagents be supplied in the correct relative proportions, yet a large percentage of all boiler-room troubles is due to failure to provide the correct amount of air for burning the fuel and adequate means for removing the products of combustion. In proportioning the height and area of the stack, full allowance must be made for the increased volume and decreased temperature of the stack gases due to air infiltration. Infiltration of air takes place through the brickwork of the setting around clean-out and dusting doors, through joints in breeching and past the dampers of dead boilers. Allowance should be made for the effect of radiation from the stack and breechings in lowering the temperature of the stack gases. The draft resistance is greatly increased by abrupt changes in direction or velocity of the gases. For this reason the number of bends in the breechings should be made as few as possible and long-radius bends used wherever possible.

Influence of Fuel on Design

The boiler baffling is usually arranged to maintain a uniform velocity of gases throughout the passes; throttling at any point will increase the resistance. In designing the stack, breechings, baffling, induced-draft fans, etc., consideration must be given to the kinds of fuel that the plant will be required to use and the maximum load to be carried. Liberal allowance must be made for the fact that operating conditions may at times be far from the efficient ones that it is hoped to maintain.

In the coal-fired plant the selection of stoker and the design of furnace (with respect to combustion volume and minimum length of flame travel) must be governed by the kind of coal to be used and the desired rates of combustion. For stand-by stations it is important that it be possible to develop the desired capacities from a banked-fire condition in the shortest time possible. With rapidly fluctuating loads flexibility is the important consideration; that is, the ability to meet sudden heavy peaks and to drop the capacity with sudden falling off in demand without loss of steam through the safety valves.

Trouble is frequently experienced in maintaining the furnace brickwork. This may be due to one of the following causes: Use of too much or an inferior grade of fireclay; failure to provide properly for expansion and contraction; too great compressive stress at high temperatures; insufficient number of, or improperly spaced, buckstays; lack of ventilation for skewbacks. In designing the furnace, the coefficient of expansion of the brick to be used should be taken into consideration. Some firebrick have a negative coefficient and some a coefficient nearly zero; for the majority the coefficient is positive.

Division Walls Overheat

It is common practice to set boilers in batteries of two although the larger units, for convenience of operation, are ordinarily set singly. With certain types of boilers it has been the practice to set any number in a solid battery. This practice cuts down the radiation losses, but this advantage is more than counterbalanced by the difficulty of maintaining the division wall between the furnaces. These walls fail quickly, owing to the high temperature on both sides of them, and are difficult to repair.

In conclusion, the writer wishes to emphasize the fact that the boiler plants that have efficient crews and are maintaining records for economy and service are those where the designer recognized the necessity for providing adequate space, lighting, ventilation and accessibility.

The Steam-Engine Indicator

Securing the Diagram From the Engine

WITH the reducing motion and pipe connections in place, the next step in indicating the engine is the assembling of the indicator itself. Since the entire operation of the indicator in reproducing the engine cylinder pressure-volume conditions depends on the accurate measurement of pressures by spring compression, it is essential that the indicator spring be accurate and of the proper strength to give a fair-sized diagram.

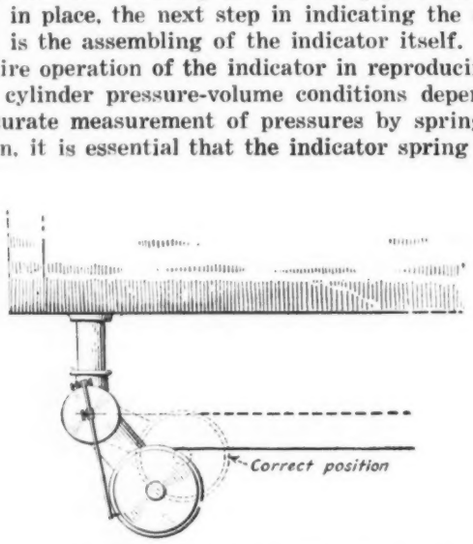


FIG. 1. INCORRECT WAY OF SETTING INDICATOR

The indicator set, when purchased from the manufacturer, is provided with from two to three springs to use with both high and low pressures. However, extra springs can be supplied and the engineer is advised to obtain at least three to give 8, 40 and 100 lb. respectively. If high steam pressures are used, a 150-lb. spring should be secured.

The principle of the indicator is based, as outlined in previous articles, on the indicator piston experiencing the same pressure per square inch as does the engine piston. This steam pressure exerted on the indicator piston is resisted by the spring. As a result, the application of a pressure underneath the indicator piston compresses the spring an amount depending upon the spring strength. This is exactly the way much of our food is weighed on a spring balance, the stretching or compressing the scale spring in this case being indicated by a pointer moving along a dial which is marked in pounds, and giving the weight necessary to alter the spring length to the new position.

With the indicator the spring is compressed, allowing the piston to move upward, which in turn gives an upward motion to the end of the pencil lever. If, for example, a 100-lb. spring is being used, 100 lb. steam pressure under the indicator piston will cause the pencil point to move one inch, the piston actually moving much less, ranging from $\frac{1}{4}$ to $\frac{1}{8}$, depending on the make of indicator. If a 200-lb. spring had been used, the travel of the pencil would have been only $\frac{1}{2}$ in., since one-inch pencil travel with a 200-lb. spring indicates 200 lb. per sq.in. pressure on the steam-engine piston, while the piston with a 1 to 5 ratio would move $\frac{1}{5}$ of an inch. So with any spring the piston travel is small.

It is apparent that the indicator spring must be accurate if the indicator diagram is to give any close representation of the steam-cylinder pressure conditions. For this reason the engineer should always use the lowest pressure spring that it is possible to use without producing inertia effects due to excessive pencil travel. For example, if the error in a spring is $\frac{1}{50}$ in., then the actual pressure error with a 200-lb. spring would be 4 lb., while with the 100-lb. spring the error would be 2 lb. For the same reason the indicator diagram should be made as long as the indicator drum will allow, since the greater the diagram length the less the inaccuracies in the reducing-motion affect the diagram; but this is counterbalanced by the sharper outline of the points of cutoff, release, etc., obtained in a diagram when a short stroke and a light spring are used. On the other hand, the spring must not be too light or the travel of the indicator piston becomes too great and the inertia effect causes errors in the diagram.

The question of proper selection of the spring to be used is often raised. In general a spring to give a diagram of at least $1\frac{1}{4}$ in. should be used. This, however, is influenced by the engine speed, and it has been found that for high speeds springs to give not over $1\frac{1}{2}$ in. height to the diagram should be used. Each spring is marked with the pressure that will give one inch travel to the pencil point; as for example, with an 80 spring the diagram will be 1 in. high with 80 lb. pressure and 2 in. high with 160 lb. pressure. To determine the spring to be used, the following rule might be applied:

Rule: Divide the boiler pressure, expressed in pounds by 1.75 for slow-speed and 1.5 for high-speed engines; the quotient will be the spring size to use.

Before inserting the piston into the indicator body, the latter should be wiped out with a clean, light cloth and then a few drops of cylinder oil placed on the piston. The oil will spread over the piston surface and any small particles of dirt can easily be seen and removed by the tip of a pencil. After inserting the piston, the pencil lever should be adjusted to bring the pencil point fairly well down along the drum. If set too high, the travel of the pencil point may cause the pencil to rise above the drum. All the joints should be lubricated

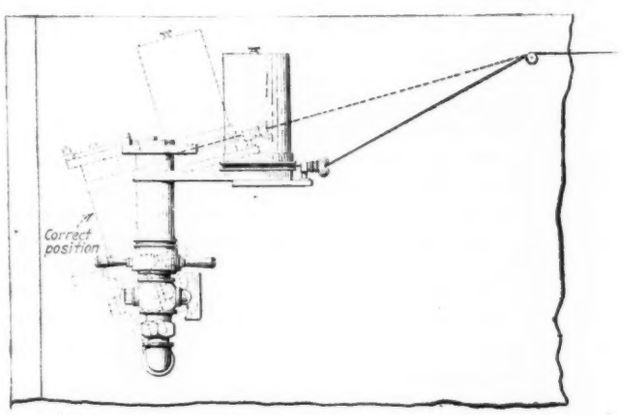


FIG. 2. PULL OF CORD TENDS TO LIFT INDICATOR BRACKET

with some light oil, such as porpoise oil supplied by the manufacturer.

Before the indicator is screwed into the engine-cylinder connection, the latter should be thoroughly blown out to remove all pipe scale or dirt. In screwing the indicator into the cock, it should be set to allow the indicator cord to travel as nearly in a straight line from the drum to the reducing motion as possible. If the cord is taken off at an angle, the cord tension causes a bending movement on the indicator bracket that may cause the indicator to become deranged or give a diagram that will be shortened and consequently worthless. This is illustrated in Fig. 1 where the indicator while in the position indicated by the full lines is subjected to twisting moment due to the angle at which the cord leaves the indicator. In the position shown by the dotted outline, secured by loosening the screw point and swinging the indicator, the center line of the cord passes through the indicator center and no twisting of the indicator occurs. In Fig. 2 when the indicator is in the position indicated by the full lines, the pull of the indicator cord tends to lift the bracket. The diagram will as a result be short and by no means accurate. By turning the elbow or indicator connection the latter may be set as shown by the dotted outline to allow the cord to travel parallel to the bracket axis. Most indicators are now arranged to allow the pencil lever to rest on either side of the drum, which is of distinct advantage since the pencil can be placed on the side of the drum that is most convenient.

Proceeding with the work, the indicator cord must next be attached to the indicator drum and made of the proper length to reach the reducing motion at the crosshead. All cord tends to stretch, and consequently errors

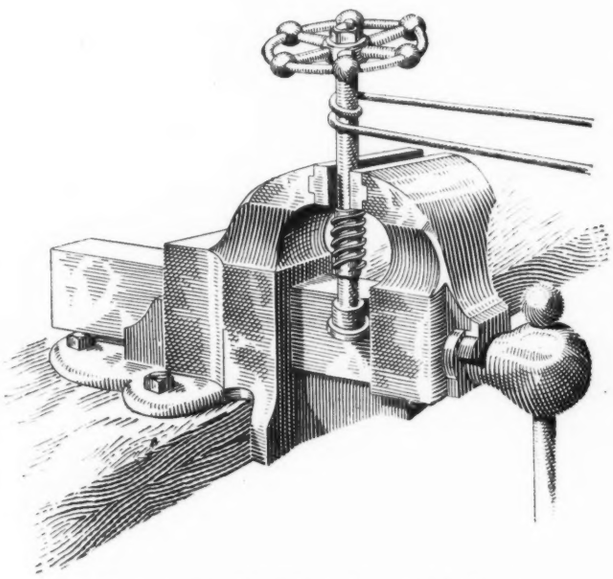


FIG. 3. STRETCHING INDICATOR CORD

arise in the diagram which will be touched upon later. To eliminate this source of trouble, it is highly desirable to stretch the cord before use. To do this the cord may be suspended from the ceiling with a ten-pound weight attached to the free end. At the conclusion of this stretching process, which, if possible, should cover several hours, the cord should be further stretched by the method shown in Fig. 3. Here an old valve stem or other round piece of smooth brass is gripped in a vise and the cord passed around the stem. By pulling the cord back and forth, advancing the cord as the work proceeds, all stretch is removed and if the cord is braided, as it should be, the strands are flattened by the passing around the valve stem.

To prevent the thread strands from wearing, the cord should be beeswaxed. This makes the cord stronger and more inclined to wrap evenly about the drum. After

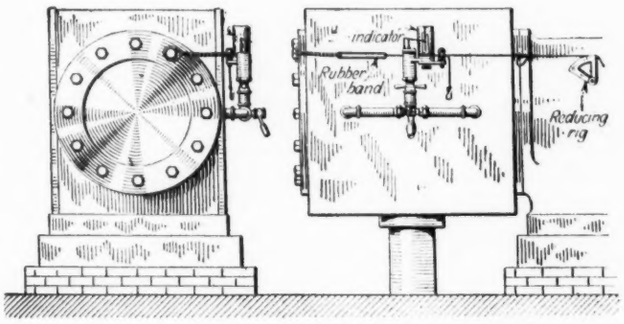


FIG. 4. GOOD WAY OF HOLDING RIG CORD

attaching the cord to the drum, it should be given one turn about the drum and then passed through the drum-guide pulley.

If the distance from the indicator to the crosshead is more than three or four feet, it is highly desirable to use only a short drum cord. To complete the distance, an annealed iron wire may be fastened to the crosshead-reducing motion with a loop at the free end. It should be straightened by pulling around a smooth pin before use. A hook on the drum cord is caught into the loop.

The free end of the drum cord must be attached to the reducing rig or iron wire in order to give the necessary travel to the drum. If it were possible to allow the indicator drum to remain in action until the engine stopped, it would only be necessary to tie the cord of proper length to the reducing rig. Indicators of certain make are provided with a detent or catch on the drum which allows the drum to be stopped for changing of cards while the cord continues in motion. This is of assistance in certain work, but it is the belief of many engineers that the cord should be unhooked and the drum allowed to remain at rest save when a diagram is being secured.

The cord then must be attached to the reducing rig in a way to allow instant detachment. The common way is to provide the reducing rig with a cord and loop and place a hook on the end of the indicator cord to engage the loop as already pointed out. If this is done, the hook should be as close to the indicator as possible to prevent the whipping of the cord which often occurs when the hook is at the end of a long indicator cord. The end of the cord from the reducing rig is best fastened to an elastic or rubber band to hold it taut. Fig. 4 shows such an arrangement, which has been very handy, especially with engines running at 150 to 200 r.p.m. or higher. If the indicator is supplied with a reducing wheel, the wheel cord rather than the indicator cord is attached to the crosshead of the engine. It is very important to make the indicator cord of such a length that, when hooked to the rig cord, the travel of the cord will not exceed the permissible drum travel. If the cord is too long, the drum will not start to move

when the crosshead reverses and starts away from the head end. The diagram will then be distorted, being shorter than it should by the amount of extra cord length. If the cord is too short, the drum will move to the limit of its travel and then the cord will break.

To determine the desired cord length while the engine is running, the hook should be slipped over the indicator cord and engaged in the loop of the rigging cord. The indicator cord is pulled through the hook eye until the drum just misses striking its stop at the end of its travel. Still holding the hook and cord at this length, the hook is disengaged and a knot made in the cord, fastening the hook. The amount of cord used in making the knot will give ample clearance between the drum and its travel limit. In hooking the cord into the loop, the engineer should put his hand on the reducing-rig cord, allowing his fingers to slip along the cord which is in motion until he reaches the loop. Now, while holding the loop so that the motion of the crosshead does not jerk it from his finger, he inserts the cord hook on the indicator with his other hand. If the end of the rigging cord is held by a rubber band, it is quite an easy matter to stretch the rubber until there is sufficient slack to prevent the cord from being jerked out of the hand by the crosshead motion. As soon as the diagram is secured, the cord should be unhooked immediately to prevent wear of the cord, which does not possess a long life under ordinary circumstances.

If a reducing motion is used, a common method of connecting the cord to the crosshead is shown in Fig. 5. Here the hook is placed against the pin on the crosshead until the pin strikes part *A*, which throws the hook into engagement with the pin.

Reverting to the point at which the indicator is connected to the engine and the cord made of proper length, etc., it becomes necessary to place upon the indicator drum a paper upon which a pencil at the end of the pencil lever will make a permanent record of the engine-

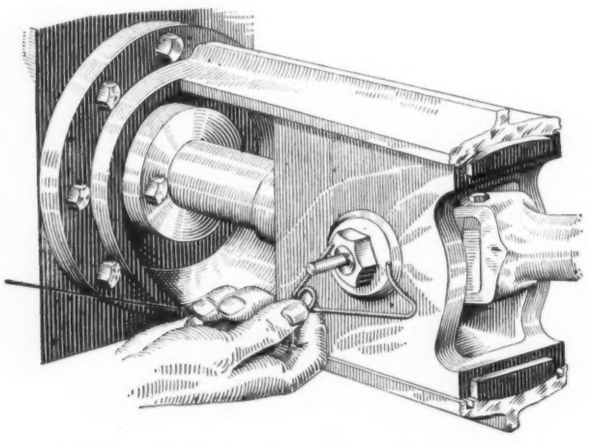


FIG. 5. HOOKING CORD ONTO CROSSHEAD

cylinder events. The paper should be of a tough character, well sized and free from wrinkles or irregularities of surface. All indicator manufacturers supply goodly amount of such cards with each instrument and are in position to furnish additional cards as required. In placing the paper about the drum, engineers use various methods. The one outlined in Fig. 6 is easy and gives a smooth card after slipping onto the drum. One end of the card is first folded back, and while holding the paper vertically, this edge is slipped behind the long clip *A*. This end is slipped down even with the top of the short clip, whereupon the free end of the card is inserted behind the latter, and after being folded back, both ends are drawn down together. This gives a smooth card and eliminates torn paper.

To make the tracing of the pencil on the paper, either a lead or metallic pencil point may be used. For ordi-

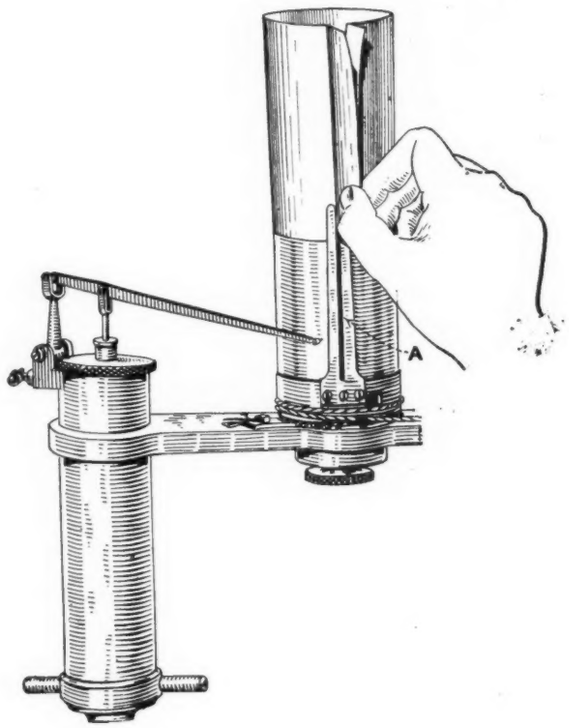


FIG. 6. PUTTING CARD ON THE INDICATOR DRUM

nary use a lead is preferable. This should not be made too long, as any extra weight at the end of the long pencil lever might produce inertia effects distorting the diagram secured. The pencil should be filed to a point, but not too sharp or the paper may be torn, nor too blunt or the pencil line may become too thick. The engineer will learn by trial the best shape to give the pencil. Metallic points are preferred in tests where special paper is used, but for ordinary use the lead is the better.

Having the instrument all ready, the indicator cock should be opened to admit steam into the indicator cylinder for warming up. It is always advisable to warm the indicator to avoid distortion or sticking of the piston. This being done, the cock is closed, and following the method already outlined, the indicator cord is hooked to the reducing rig, the steam turned into the indicator and the pencil lightly pressed against the card on the drum, and the diagram secured. The cock is now closed and turned so that the indicator is open to the atmosphere through the vent hole in the cock. The atmospheric line is then drawn on the diagram. This should be done after making the diagram and not before, for with a cold indicator a considerable error may be introduced by the latter method, especially with an inside spring. The indicator cord is then unhooked and the card with the diagram secured removed. It is always desirable to secure diagrams from both ends of a steam engine. This can be done, as has been pointed out, either by the use of the three-way cock or by the

employment of two indicators. If the three-way cock is used, the two cylinder ends give diagrams which, when taken on one card appear as in Fig. 7. The diagram marked head end represents the events taking place in the cylinder between the piston and the cylinder head, while the crank-end diagram shows events occurring in the cylinder space between the piston and crank-end cylinder head.

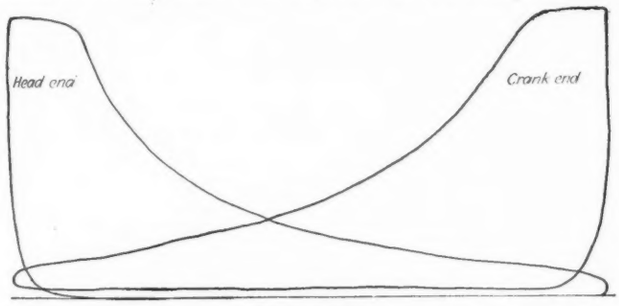


FIG. 7. INDICATOR DIAGRAM FROM BOTH ENDS OF THE CYLINDER

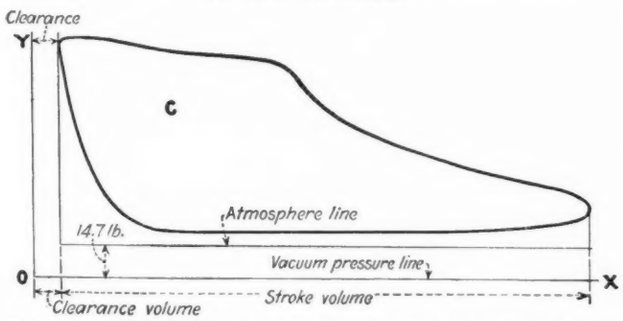


FIG. 8. CONSTRUCTING CLEARANCE AND VACUUM LINES

Since the indicator diagram shows the volume swept by the piston, at the beginning of the piston stroke there is, between the piston and cylinder head, a clearance volume which must be filled with steam and which does not show on the diagram. Before any study is made of a diagram it is necessary to lay off this clearance. The length of the indicator diagram represents the piston stroke which, when multiplied by the piston, gives the stroke volume, and so the diagram length is proportional to the stroke volume.

The clearance volume consists of the space in the ports and the space between the piston and head. If this volume is known, it may be laid off at the end of the diagram to the same scale as the stroke volume. As example, the stroke volume of a 24-in. diameter by 24-in. stroke engine is 6.283 cu.ft. and if the indicator diagram is 4 in. long each inch of diagram length represents 1.571 cu.ft. of stroke volume. If the clearance volume is 0.25 cu.ft., a point $\frac{0.25}{1.571} = 0.16$ in. from the end of the diagram should be made and a vertical line OY drawn through it as in Fig. 8. This line is the zero clearance line of the diagram. To find the clearance volume, the engine may be put on dead center and, by connecting a vertical pipe to the indicator opening into the engine cylinder, the clearance space may be filled from a bucket of water which is weighed before and after the process. The difference is the weight of water filling the clearance volume. This divided by 62.35 (the weight of a cubic foot of water at 62 deg. F.) gives the clearance volume in cubic feet.

Likewise the vacuum line or zero pressure line OX, Fig. 8, is constructed by drawing a line below and parallel to the atmospheric line and at a distance from it equal to 14.7 lb. In extremely accurate work when a low scale spring is used, the atmospheric pressure should be corrected to conform to the barometer reading.

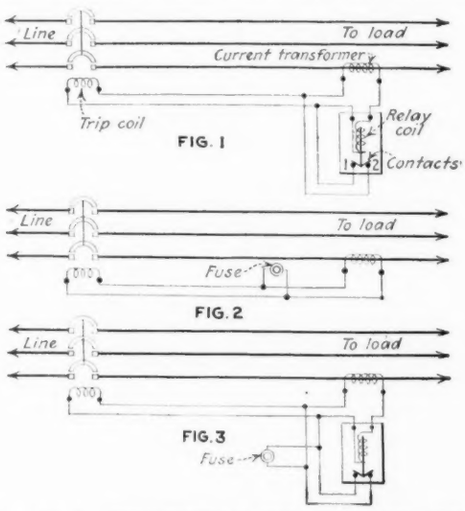
Temporary Protection Proves To Be Permanent

BY VICTOR H. TODD

A large induction motor was protected by a circuit breaker which in turn was controlled by a series-trip, inverse time-limit bellows-plunger type relay connected to the secondary of a series transformer. As will be readily seen by Fig. 1, contacts 1 and 2 of the relay normally short-circuit the trip coil of the breaker so that no current flows through this coil. When the overload occurs, the relay coil pulls the plunger up, thus opening contacts 1 and 2, and allows the current to flow through the trip coil and open the breaker. In practice it was found difficult to keep the contacts clean, and many times the motor was tripped out without overload.

One day, however, the relay had to be taken out for repairs. Rather than leave the motor without protection, the trip coil was connected directly across the transformer secondary, but was short-circuited through a 6-ampere plug fuse, as in Fig. 2. Upon overload this fuse would blow, and then the entire current from the transformer would flow through the trip coil and open the breaker. This, of course, did not give any time delay.

This scheme proved so satisfactory that when the relay was reinstalled, a plug fuse was connected directly across the contacts so that normally very little current



FIGS. 1 TO 3. CONNECTION FOR TRIP-COIL CIRCUIT

flowed through the fuse or trip coil. When the overload occurred, the contacts opened, causing the current from the transformer to flow through the fuse, which would blow and thus cause all the current to flow through the trip coil and trip the switch.

It may seem poor practice to install fuses in addition to the relay, but in this case the motor was not overloaded frequently, therefore the cost of replacing a fuse was a very small item compared to the stopping of the motor without cause. The fuse must be used with caution, since if a blown fuse were bridged with a wire, it would cause a burnt-out motor in case of overload.

The Care of Transformer Oil

Effects of Moisture—Preventing Moisture From Getting into the Oil—Cleaning Transformer Windings—Sampling and Testing—Methods of Drying Oil

By J. B. GIBBS
Engineer, Transformer Department, Westinghouse Electric and Manufacturing Company

PROPER care of transformer oil may be summarized in one sentence—"Keep it clean and dry." Good transformer oil, when free from moisture, should not break down at less than 22,000 volts when tested between the flat surfaces of two parallel discs, one inch in diameter and one-tenth of an inch apart. A very small quantity of water in the oil causes a large decrease in its ability to withstand high voltage (dielectric strength); for instance, 0.005 per cent of moisture will lower the breakdown voltage across the gap to about half that for dry oil.

How Moisture Finds Its Way Into Oil

Moisture may find its way into transformer oil in several ways. The oil is frequently shipped in metal drums, and if these are exposed to rain, moisture may enter around the threads of the bung or through imperfections in the seams. The obvious way to prevent this is to store oil containers in a dry place. In water-cooled transformers, the portions of the water pipes which extend above the oil level are always heavily lagged with a heat-insulating material. If this lagging is damaged, moisture in the air inside of the transformer may be condensed on the cold-water pipe and may run down into the oil. The lagging should therefore be kept in perfect condition. Another source to which the presence of moisture in large transformers is sometimes attributed is the "breathing" of the transformer. When the transformer is loaded and becomes warm, both the oil and the air in the tank expand, and if there is a vent a part of the air will be forced out

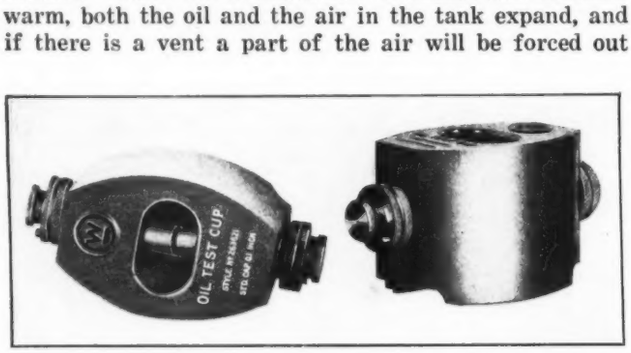


FIG. 1. TRANSFORMER OIL TESTING CUP

of the tank. When the load is disconnected and the transformer cools, this action is reversed, and a corresponding volume of air is drawn into the tank from the atmosphere. This air carries a certain amount of moisture, and a part of the moisture may be condensed inside of the tank. To prevent this, a "breather" is sometimes used. This consists of a small chamber filled with calcium chloride through which the entering air must pass. It effectively dries the air, but the breather requires periodic inspection to keep it in operative condition. If the calcium chloride is allowed to become saturated, it is worse than useless. Breathers are almost never supplied except on large transformers which have airtight cases and covers. On all other transformers the general practice is to use a felt gasket between the case and the cover and to clamp the cover down tightly on the gasket. Experience has shown that with this construction the effect of breathing is negligible.

It is self-evident that any foreign matter in the oil is a possible source of danger, and oil is usually han-

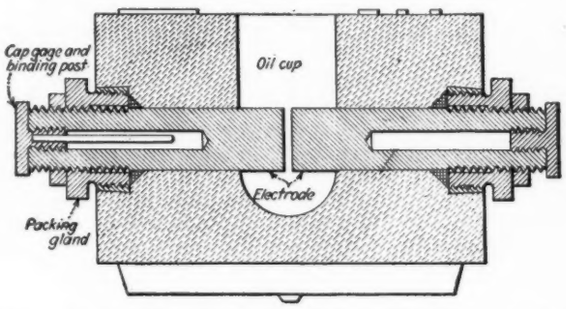


FIG. 2. CROSS-SECTION THROUGH TEST CUP, FIG. 1

dled carefully enough to keep it clean. Certain transformer oils which have been used in the past will throw down a heavy precipitate, or sludge, when overheated; and this may coat the coils and fill up the oil ducts so as to cause the transformer to overheat on normal loads. Modern oils show very little of this effect, but if sludging has occurred, the transformer should be removed from its tank and the coils thoroughly washed with oil, under pressure if necessary, to remove the sludge and to clear the oil ducts. The tank should be emptied and cleaned in the same way, and the oil filtered, if it carries any floating particles. If the oil has not been seriously overheated, it may be replaced in the tank. Any overheating tends to darken the color of the oil and to increase its viscosity somewhat, but the increase in viscosity is usually small, and the dark color does not indicate any change for the worse in the dielectric properties of the oil.

Testing Condition of Transformer Oil

The condition of transformer oil is tested by drawing a sample from the bottom of the tank. Water is heavier than oil, and if there is moisture in the tank the oil at the bottom will show it. Most transformer tanks are provided with a small valve or a plug near the bottom of the tank for sampling the oil. If a sample is desired from a tank that has no such outlet, it may be obtained by using a small pipe or glass tube long enough to reach to the bottom of the tank. Place the thumb tightly over the top of the pipe to keep the air from escaping, and thrust the pipe down to the bottom of the tank. Then remove the thumb and allow the pipe to fill with oil. Replace the thumb over the end and remove the pipe full of oil. This should, of course, be done while power is shut off from the transformer.

The most reliable test of the condition of the oil is the breakdown test. This is made by placing a sample of the oil taken from the bottom of the transformer in a vessel containing a standard spark gap, and gradually raising a voltage until breakdown occurs. Two forms of standard spark gap are recognized by the National Electric Light Association. One is composed of two spheres, each one-half inch in diameter and with a gap of 0.15 in.

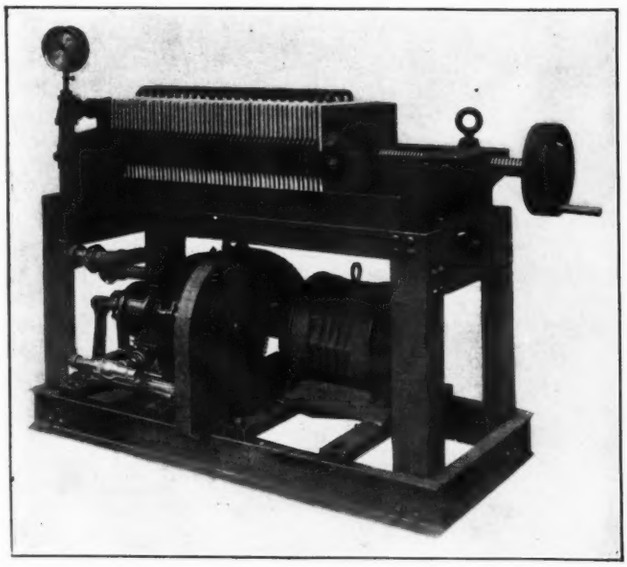


FIG. 3. FILTER FOR TREATING TRANSFORMER OIL

between the two. The other is composed of two discs, one inch in diameter and set 0.10 in. apart. The N. E. L. A. recommends that transformer oil be treated if an average of five tests shows less than 30,000 volts required to break down the oil in the first type of gap or less than 16,500 in the second. Fig. 1 shows the photograph and Fig. 2 a cross-section of a convenient form of spark gap. It consists of a molded cup of insulating material in which are mounted two metal cylinders with flat ends. Screwed into one of the binding posts, the left-hand one in the cross-section, is a wire exactly 0.10 in. in diameter, and the use of this as a gage makes it easy to set the gap accurately.

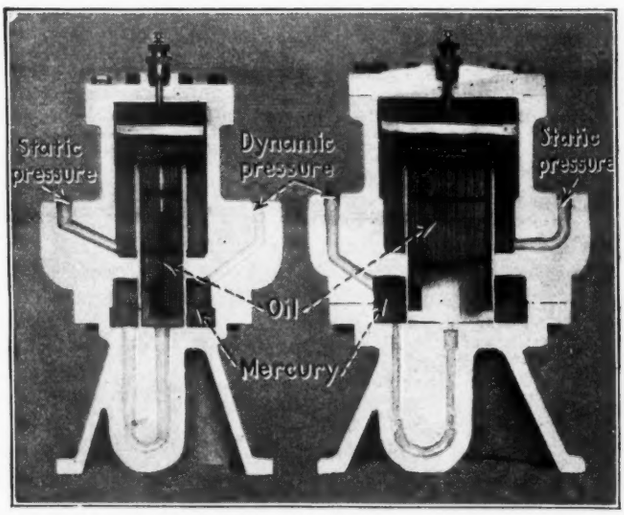
If the test shows that moisture is present, the oil should be thoroughly dried. The best and most convenient method of cleaning and drying oil is by the use of an oil-treating outfit. This consists of a small motor-driven pump arranged to draw oil from the tank and force it through a series of blotting papers. The blotting paper absorbs the moisture by capillarity, and stops all solid particles, allowing the clean dry oil to pass. When the blotters become moist they can be removed, dried and replaced. Most large transformers are provided with a pipe connection near the bottom of the tank and another near the top so that the oil-treating outfit can be attached and the oil purified without shutting down the transformer. Fig. 3 shows a large oil-treating equipment. It provides a number of parallel paths through blotting paper for the oil, and is capable of treating 30 gal. per min. Several smaller sizes are obtainable.

In the absence of an oil-treating equipment oil may be dried by passing it through unslaked lime until the moisture is removed and then filtering to remove all floating particles. Another plan which has sometimes been used is to heat the oil in the tank, either with resistance grids immersed in the tank or by external heat applied to the bottom of the tank. This process is open to serious objection. The oil near the source of heat must evidently be hotter than the average oil temperature, and is frequently very much hotter. The high temperature, maintained for a long enough time to dry the oil, is usually sufficient to darken its color considerably and also to cause a precipitate which changes the composition. If the top of the tank can be closed and a vacuum can be maintained above the oil, the water can be evaporated at a lower temperature, but for convenience as well as for safety to the oil, the oil-treating equipment is preferable.

To minimize the possibility of trouble from moisture in the oil, tests should be made at regular intervals. The N. E. L. A. recommends that oil samples from all power-station and substation apparatus be tested at least once every three months and from distribution transformers at least once a year. If the tests show that the oil is not in perfect condition, it should be treated. Transformer users who do not care to undertake oil testing for themselves can usually arrange with the manufacturer of the apparatus to make the tests on samples submitted by the user.

Republic Flow-Meter Redesigned for Greater Accuracy

Improvement in the design of the Republic electrically operated flow-meter has been made by increasing the number of electrical contact points from 41 to 91. The new meter, therefore, covers the same range of flow as the old one[1] in more than twice as many steps, so that the possible discrepancy between the



LEFT, THE OLD METER, AND AT THE RIGHT, THE IMPROVED TYPE WITH 91 CONTACTS

actual and the indicated rates of flow is correspondingly reduced.

The principle of operation remains the same. The dynamic pressure from a Pitot tube that is inserted in the fluid being measured, is carried into the large annular chamber, as shown in the illustration. There

[1]Described in *Power* for Nov. 2, 1915, page 612, and for Nov. 24, 1914, page 744.

is mercury in the latter space and also in the inner chamber at the bottom of the contact rods, the two spaces being connected by the U-shaped passageway. On top of the mercury in the inner chamber is oil, which is affected by the static pressure from the Pitot tube through the second opening, as shown in the cut. As the flow increases, the differential pressure in the Pitot tube raises the level of the mercury, thus making electrical contact with one after the other of the 91 rods, and cutting out successively the resistances to which they are connected. These resistances are in circuit with electrical instruments, the readings of which are calibrated to indicate the flow of steam or other fluid in the pipe.

It is claimed that the change in the design of the meter has reduced the maximum possible error at any one instant from 1.125 per cent to 0.5 per cent of the range of the meter. Even the latter error, however, will scarcely be reached, because the rate of flow changes continually, even though through small limits. Thus the errors will be first positive and then negative, so that they will average, and produce an actual error of less than 0.5 per cent.

The meter is protected by a mercury safety seal. The device is made by the Republic Flow Meter Co., of Chicago.

Governing Mechanism for Mixed-Pressure Turbine*

As the name implies, "mixed-pressure" turbines are designed to run on both high-pressure and low-pressure steam at the same time, using low-pressure steam so far as it is available and enough additional high-pressure steam to carry the load. This high-pressure steam is, of course, admitted to the first stage of the turbine while the low-pressure steam enters one of the intermediate stages.

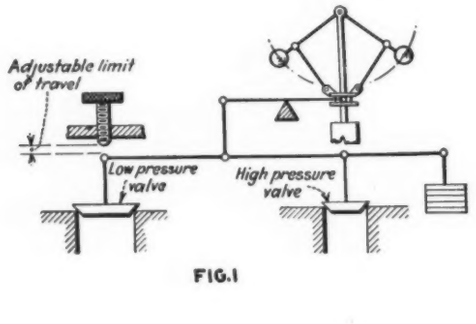


FIG.1

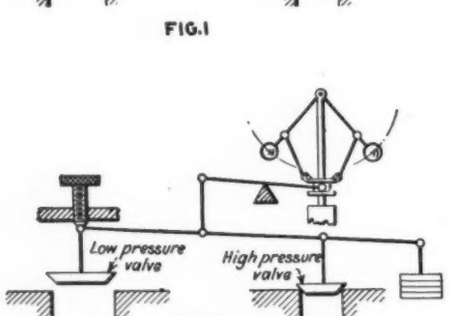


FIG.2

FIGS. 1 AND 2. OPERATION OF MIXED-PRESSURE GOVERNOR

Fig. 1—No load—Both valves practically closed. Fig. 2—Load has increased until low-pressure valve is wide open—high-pressure valve still closed.

*From information supplied by the Terry Turbine Company.

Figs. 1, 2, 3 and 4 illustrate diagrammatically the operation of the Terry governing mechanism for mixed-pressure turbines. Fig. 1 shows the mechanism when the turbine is running at no load with both valves practically closed. Now assume that a small load comes on the turbine, producing a slight reduction in speed. The consequent lowering of the governor balls acts through a lever and vertical link to pull upward on the horizontal bar to which are connected the two valves and a weight (shown at the right). From the location of this pull and the weight, as shown in Fig. 1, it is evident that the first effect must be to open the low-pressure valve. As the load increases, the low-pressure valve opens wider until it reaches its limit of travel, as indicated in Fig. 2.

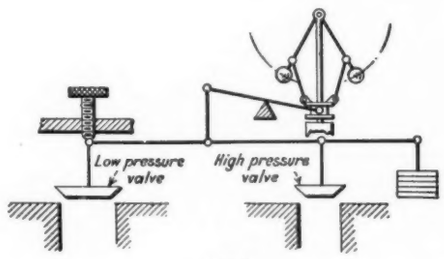


FIG.3

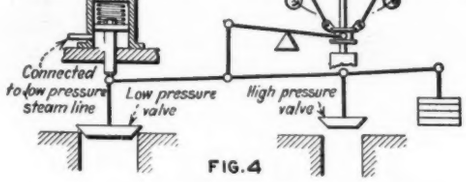

Reteau mechanism for automatic regulation of limit of travel
Connected to low pressure steam line
Low pressure valve
High pressure valve

FIG.4

FIGS. 3 AND 4. OPERATION OF MIXED-PRESSURE GOVERNOR

Fig. 3—Maximum load—Low-pressure valve open to limit of travel—high-pressure valve wide open. Fig. 4—Governor with Rateau automatic travel regulator on low-pressure valve.

Further increases in load lift the high-pressure valve from its seat while the low-pressure valve remains wide open. This is shown in Fig. 3. By adjusting the traveling of the low-pressure valve, it is possible to vary the point at which the high-pressure valve opens. As the available quantity of low-pressure steam is reduced, this limit should be cut down so that the low-pressure valve cannot open so wide.

When there is too frequent fluctuation in the supply of low-pressure steam, it becomes necessary to use a device that will automatically control this limit of travel. Such a mechanism, called the Rateau Control, is shown diagrammatically in Fig. 4. When the pressure in the low-pressure main falls, the spring forces down the small piston together with the travel stop which is connected to it.

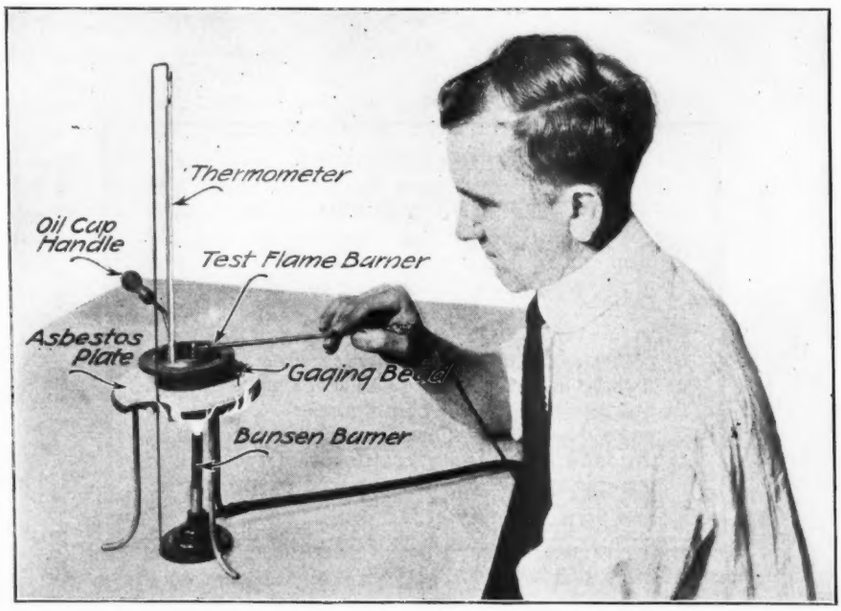
Progress in the design of waterwheels during the last twenty-five years is strikingly illustrated at Niagara Falls, where in the early installations only 10.6 hp. per second-foot of water was obtained, as compared with the latest designs, which permit a utilization of 22 hp. per second-foot. Reconstruction of the Niagara plants that is now going on, will make available an additional 100,000 hp. with the same quantity of water, due to improved design.

Lubrication—Flash and Fire Tests

By W. F. OSBORNE

A TEST which has been given undue prominence in the preparation of specifications for lubricating oils is the flash point. When oil is heated, it gives off vapor, the amount depending upon the temperature and the characteristics of the various hydrocarbons contained in the oil. Some petroleum products, such as gasoline, evaporate very rapidly at ordinary temperatures; others, like kerosene and fuel oil, evaporate much more slowly. Lubricating oils evaporate so slowly at atmospheric temperatures that a coating of oil will protect metal from rusting for a long time.

The flash test is made by heating a definite quantity of oil in a cup under certain conditions and measuring the temperature at which vapor is given off fast enough to form with the air above its surface a mixture that will ignite upon the introduction of a small flame. If the heating is continued until the vapor is given off fast enough to burn continuously, the temperature at which this takes place is called the fire point.



METHOD OF OBTAINING FLASH TEST (CLEVELAND OPEN TESTER)

Particular attention is called to the fact that neither flash nor fire occurs unless the vapor is ignited from an outside source. This means that a lubricating oil will not flash or burn spontaneously until it is heated to a temperature very much higher than the fire point, and there is no danger of spontaneous combustion even though the oil be used under temperatures considerably above the flash or fire points.

The actual flash point varies with certain properties of the oil, such as the vapor pressures of its constituents, the percentage of each present and with many other factors such as the quantity of oil, the rate of circulation of air above its surface, the agitation of the oil and the pressure above its surface. This means that in order to duplicate results, the conditions under which the flash points are taken must be carefully maintained identical.

Technical Paper No. 49 of the Bureau of Mines, states: "Flash point is not an indication of the value of an oil for any particular purposes. It is an indication only of the temperature at which oil gives off vapors in such proportion that they form an inflammable mixture with the air." It certainly has nothing to do with lubricating value or the reduction of friction.

The flash test was originally developed for the purpose of determining the fire hazard involved in the shipment and storage of oil, and it is today of value principally for that purpose. It evidently indicates fairly accurately the comparative inflammability of oils under atmospheric pressure.

Although the flash point is certainly a fair means of comparing the volatility of two oils at temperatures near the flash point, it does not follow that it is of any value in comparing their volatilities at other temperatures. Volatility is determined by the vapor pressures of the various constituents of the oil, and as the rate at which the vapor pressure increases with increased temperatures is not the same for all hydrocarbons, the relative volatility of two oils at one temperature cannot be used as a measure of their relative volatility at some other temperature. Two oils might have identical flash points and yet one oil might evaporate more rapidly at 180 deg. F. than the other oil.

Furthermore, increased pressure has a varying effect on different oils, and the actual rate of evaporation under variable pressures cannot be predetermined from their flash points.

Briefly, we may say that if two oils are to be used under pressures and temperatures similar to those under which the flash test is made, the flash test is undoubtedly of value in comparing the rate of evaporation and economy of the two oils.

Even though one oil might show a greater rate of evaporation under certain operating conditions than another oil, the actual difference in the consumption due to this difference in volatility will not be large. Furthermore, the oil which shows the greater consumption might possess some very desirable properties which would be of greater importance than a slight increase in the amount used.

Summarizing, we may say that under very limited conditions the flash point may be of some value in indicating the volatility of an oil, but it does not tell us anything about the frictional reducing qualities of the oil nor anything about its decomposition in use.

Q. Which is the better lubricant, a low or a high flash oil?

A. Flash test has nothing to do with the lubricating qualities of an oil.

Instructing Power-Plant Operators

Problems of Making the Operator Familiar with the Equipment for Which He Is Responsible—Methods of Providing Proper Instructions

By J. A. MacMURCHY
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MANUFACTURERS of machinery requiring special attention or involving special knowledge on the part of the operators have been furnishing instruction books with the machines in the hope that the information contained in these books would enable the operator to take proper care of the machines. These books, however, do not seem to get to the operator, or if they do, they do not remain with the machine in case the operator resigns. Instruction books mailed to a customer seem to get no farther than the office of the manager or superintendent. Realizing this, some manufacturers make a practice of mailing these instruction books and also sending out an additional book tied to the machine or packed in the box with it. Even this does not seem to be effective in many cases, for apparently the man who unpacks the machine is attracted by the information in the book and keeps it for himself.

If the manufacturer installs the machinery, this gives the erector they sent out an opportunity to explain personally to the operators just how the machine should be cared for and demonstrate how successfully it will work if the instructions are followed. Of course some erectors are more successful than others in instructing the operators and get the latter to take charge of the machines while they are still on the job. In this way they not only operate the machine, but have the operator make such adjustments and changes as he may be called upon to do later. In this way he is given confidence in his ability to take care of the equipment properly. This method of instruction is perhaps the best of all, but it has the weakness that when the operator leaves he may not transmit this information to his successor.

There seems to be a growing tendency to put small instruction plates at various places on a machine, these indicating to the operator some of the things to do and some of the things not to do at the particular point where the instruction plate is attached; for instance, such markings as "Oil Here." In one case in mind, of a motor, a large brass plate bore the statement, "Do Not Oil the Commutator." At first glance this seemed amusing, but on second thought the instruction would seem justified.

There does not seem to be any limit to the things which may be done by those responsible for machinery operation. For instance, a short time ago a manufacturer furnished a small direct-connected turbine to a customer who at some time in the past had had an engine of the type in which it was necessary to put a quantity of oil in the crankcase for splash lubrication. This customer, remembering that he had to do this with his old engine, promptly poured oil into the turbine cylinder until it was about one-third full. It may be interesting to know that he also oiled the commutator. It is probably hopeless to expect to get sufficient instruction plates on machines to avoid every such case, but if it is possible to avoid the more common errors, the expense of putting the plates on is justified.

A card of instructions can often be hung up close to the machine. If it is framed, there is less liability of its being carried away than if it is just a loose card, and will, of course, remain clean and legible for a longer time. A framed instruction sheet of this kind may contain sufficient information for a fairly simple machine and be reasonably well illustrated, and yet not be very large. One of the difficulties of such a scheme is that in the case of auxiliary apparatus in a large power plant there may not be any place near the particular machine where such an instruction sheet can be hung, and unless it is near the machine to which it applies, its value is rather questionable.

> In obtaining satisfactory service from equipment, few factors rank in importance with proper instructions to those who are responsible for its operation. The manufacturer of the equipment, purchaser, management and operator are all vitally concerned, for if the equipment fails to give service, each is a loser in some form or another. Practically every manufacturer of power-plant equipment can recall cases where expensive apparatus has been seriously damaged due to the operator not being properly instructed. The purchaser has suffered heavy loss on account of the failure and the operator lost his job, all of which might have been prevented by proper instructions.

A modification of a framed card would be to have these instructions mounted on a thin steel plate covered with a sheet of celluloid by a special process. Cards of this kind can be obtained at a reasonable price and are remarkably durable. They are also somewhat easier to read than printed or typewritten matter covered by a sheet of glass. In some cases manufacturers go to the expense of making up polished brass plates with etched lettering with certain parts of the text in red enamel and other parts in black. This seems unnecessarily expensive, and it is probably justifiable only in the case of very valuable machinery or where there would be danger of serious injury to the operators if they did something which the plate warned against.

No one general rule can be made to apply to all classes of machinery. Some machines will be so simple that the operation is obvious and no particular harm can be done if the operator does not do just the right thing. Others may require a brief instruction plate fastened to the machine, while still others may need a number of small instruction plates attached to

the different parts of the equipment, and supplemented by a larger framed or enameled sheet to be hung on the wall. In some cases it may be desirable to supplement both of these by a carefully written and well-illustrated instruction book.

It is much easier to say that instruction books should be written well than it is to get them written, for manufacturing concerns seldom have anyone in their organizations who is well qualified to write an instruction book. The engineer who designs and is responsible for the apparatus usually has this duty delegated to him on the general ground that he should know more about the apparatus than anyone else. However, a man may be a good engineer and yet be a poor man to write an instruction book, for merely understanding the machine is by no means sufficient qualification for this duty. The person who writes an instruction book should be able to put himself in the place of the operator and see things from the latter's point of view, but unless he has been an operator himself, it is rather hard to do this. An engineer is likely to suppose that everybody knows as much as he does, and that the operator is not any more liable to do a foolish thing than he would. Again, his language may be somewhat technical and may not convey to the man who reads the instruction book the exact shade of meaning that the engineer had in mind.

In writing an instruction book it is desirable that the language used be as simple as possible, and at no time should it be capable of having two meanings. But no matter how well the text of an instruction book may be written or how graphically the machine may be described or how plainly the function of each part of the apparatus is explained, it is necessary that an instruction book be well illustrated. Illustrations may be divided into two classes, one being reproductions of drawings, particularly cross-sectional drawings through the assembled apparatus, and the other group being photographs of the machine, whether complete or partly assembled. It is not true that everybody can read a drawing. A cross-sectional assembly of a machine means practically nothing to many otherwise intelligent people, and unfortunately, the man who cannot understand such a drawing is sometimes unwilling to admit it. Reproductions of drawings are, however, desirable and in many cases necessary. Probably the best thing to do is to make the drawings as clear as possible, add all the notes which will help to make them clear, and then supplement them with photographs of the parts.

A common mistake in instruction books is to make the illustration too small or to have some of the notes or figures too small to be legible. It is not often that an ordinary working drawing can be reduced to the size necessary for the instruction book and at the same time have the figures on it large enough to be clear. It is usually necessary to make a special drawing with unusually large figures so that when the drawing is reduced the figures will still be large enough to be easily read. Any reference in the text to the drawings must be supplemented by some means of making clear what part of the drawing is referred to, as for instance, a letter or a figure with an arrow running to the particular point.

An instruction book should be marked so that it will not be applied to some other machine than that to which it was intended to apply. This may involve some extra expense in getting it out, but the man who reads the book cannot be expected to be familiar with the variety of apparatus which the manufacturer builds. Frame numbers and other designations which may be quite definite and clear to the writer of the book may mean absolutely nothing to the man who is reading it unless there is some identification mark on the machine. In larger apparatus it is worth while to specify the serial number of the machine to which this book applies. These numbers can be put on the cover of the book by typewriter or otherwise. If the instruction book is worth printing, it is worth while to be sure that it will not be misapplied.

There are certain large and costly machines that are not likely to be duplicated, or of which a limited number are built, and for these an instruction book in the ordinary sense does not apply. The owners do not trust such a machine to some employee whom they pick up casually, but to men who have been carefully selected and properly trained and instructed. Even these men, however, do need something to refer to when it is necessary to make repairs to the machine or to make adjustments, or on occasions when the machine does not seem to operate as it should. For this purpose the proper thing to send out is the set of the assembly drawings and lists of material which the shop used in the manufacture and assembling of the machine.

> Employers should, for their own protection, insist that operators read and carefully follow such instructions as are sent out by the manufacturer. They should also see to it that a proper place is provided for filing any instructions that come with the machinery and see that the instruction books are kept in this place.

Manufacturers are sometimes unwilling to send out drawings of machines, feeling that they may get into the hands of their competitors who might thus obtain information which the manufacturers properly consider as their personal property. It is doubtful if this often happens. The class of operators to whom such drawings would be given are in most cases men who can be trusted not to make any improper use of them, and in any case the risk is so extremely small and the advantage to be gained so great there should be no question about sending out the drawings. In the case of smaller and less special apparatus for which there is a somewhat general demand, the manufacturer is quite justified in refusing to send out working drawings, as they represent a very great investment on which he is entitled to make a reasonable profit and he ought not to be expected to transmit more information than is necessary to enable the operators to handle properly the machine.

Instruction books should convey sufficient information to enable the customer to order repair parts in such a way that there will be no misunderstanding as to what he wants. He should also be advised of such limitations as the manufacturer must impose in furnishing repair parts, such as advising that a certain part cannot be sent out by itself, but must be accompanied by certain other parts assembled with it. This

matter of making easy the ordering of repairs is a good investment for the manufacturer of machinery. Probably many more repair parts would be ordered direct from the manufacturer if the owner of the machine knew just how to order them. The experience of an operator ordering parts as best he can, and then after a lapse of some time receiving word that the manufacturer does not know what is wanted, is not an encouraging one, especially when nothing is done to make it easier to order the parts or to make it clearer the second time. Repair parts are usually sold at a good profit, and if the instruction book will bring in any more orders for repairs it may pay for itself many times over.

Writers of instruction books sometimes try to take advantage of the opportunity to explain how much better this particular machine is than that of any of his competitors and argue its merits. This is rather out of place in such a book. The object in mind should be to convey useful information to the operator. It may, however, be advantageous to discuss the reason for the particular construction and in that way make more clear to the operator what to do in an emergency.

The Ideal Instruction Book

This brings up another point that might be touched upon briefly. The ideal instruction book is one in which all possible mishaps that might befall the particular machine are discussed, and which points out the defects and weaknesses in the design. For obvious reasons it is not often that the manufacturer, and particularly the designer, is willing to discuss such matters fully, but at the same time as much of this as possible should be done. Probably the nearest approach to this that can be expected will be the instruction books in which the writer transmits something of the thought that was in the mind of the designer and gives the reasons for making the construction as it is. If the operator knows that results were expected of the particular mechanism or device, he will be in a much better position to diagnose and correct any trouble that is experienced. Possibly this is only another way of saying that the writer of the book should imagine himself in the position of the operator and give the latter the information that the former would like to have had if he were in the operator's place.

But having done all this, practically no good is accomplished unless the operators will, with open minds, read the instructions that are written for them. Most of them are anxious to obtain such information and assistance as will enable them to get the best results possible with the machinery in their charge. Such operators will read their instruction books and will carefully keep them for future reference. There are, however, others who feel that it is not possible to learn anything by reading, and there are even some who are not willing to be told. These men may succeed in their work as long as they are only called upon to operate machinery with which they are already familiar. They are, however, dangerous to have in charge of valuable equipment involving new principles and calling for knowledge which is not obtained by the operation of other machinery. Needless to say, it is only by the co-operation of both the manufacturer, purchaser, management and operator that the best results can be obtained with the operation of modern power-plant and manufacturing equipment.

A Short Cut in Figuring Areas of Circles

The customary way of obtaining the area of a circle is to square the diameter and multiply the result by 0.7854. In performing the second operation, there is a short cut that saves time and involves no loss of accuracy.

Suppose, for example, that the diameter of a circle is 94 inches. The square is then $94 \times 94 = 8{,}836$. Ordinarily, the multiplication is worked out in one of the two following ways:

8836		8836
.7854		.7854
35344		61852
44180	or	70688
70688		44180
61852		35344
6939.7944		6939.7944

The short-cut way of performing the same multiplication is as follows:

8836
7

(*a*) 61852 —the product of 8,836 by 7.
(*b*) 61852 —same as (*a*) shifted one space to the right.
(*c*) 123704 —double (*b*) shifted one space to the right.
(*d*) 123704—same as (*c*) shifted one space to the right.

(*e*) 6939.7944—sum of (*a*), (*b*), (*c*) and (*d*).

The result (*e*) is exactly the same as obtained in the ordinary manner. In shifting one space to the right always go by the right-hand end for simplicity, although item (*c*) is the only item where a mistake might occur if the left-hand end were used. Point off the answer exactly as though the diameter squared had been multiplied by 0.7854.

The explanation of this method is simple. The number 0.7854 may be broken up into its parts as follows:

0.7
0.08
0.005
0.0004
0.7854

The ordinary method is equivalent to multiplying 8,836 by 0.7, 0.08, 0.005 and 0.0004 in turn and taking the sum of the products. Any other series of numbers that will add up to 0.7854 can be used in the same way The short cut is based on the following series:

(*a*)	0.7
(*b*)	0.07
(*c*)	0.014
(*d*)	0.0014
Total	0.7854

In the problem shown it is evident that we followed this series, since 0.07 is 0.7 moved one place to the right; 0.014 is 0.07 doubled and moved one place to the right, and 0.0014 is 0.014 moved one place to the right.

When motors rated on a 50-deg. basis are used to drive centrifugal pumps, it is recommended by the Hydraulic Society that they be selected with an extra margin of capacity at least 20 per cent above the actual horsepower required by the pump. Where the motors are rated on a 40-deg. basis, the society recommends an extra margin of capacity of 5 per cent.

Tests on Motor-Operated Gate Valves for High-Pressure Steam

Emergency-Closing Tests Made on Five Motor-Operated 6-in. to 10-in. Gate Valves, Against Steam at 225 lb. Pressure and 150 deg. F. Superheat Blowing to Atmosphere

By T. W. STINSON
Consulting Mechanical Engineer, Public Service Production Company, Newark, New Jersey

SEVERAL years ago the extensive application of motor drive to large steam and water valves in power stations became quite general practice. These motor drives for valves were arranged with limit switches, so that remote control of the opening and closing of the valves could be accomplished. The reason for applying motor drives to valve operation was threefold:

1. To provide for the remote control of valves without the necessity of providing elaborate access platforms, stairways, ladders, etc.
2. To eliminate the use of manual labor, oftentimes under very severe conditions.
3. To provide means for quickly closing important valves under emergency conditions, especially in case of serious breaks in the main steam piping. From time to time, however, experience with the present type of gate valve, where equipped with motor control, has shown that there is considerable doubt in regard to the operation under emergency conditions.

In the 1921 Report of the Prime Movers Committee of the National Electric Light Association experience with an 18-in. double-disc gate valve with parallel seats

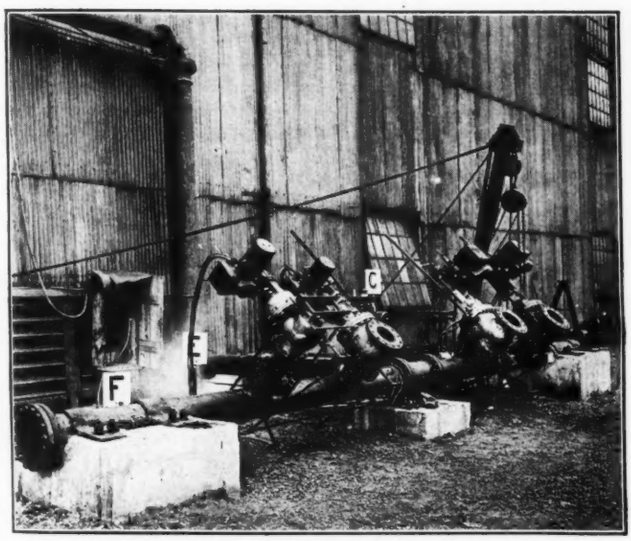


FIG. 1. VALVES TO BE TESTED INSTALLED ON 10-IN. HIGH-PRESSURE TESTING HEADER

is reported. This valve controlled steam to a 20,000-kw. turbine and an attempt was made to close the valve with a load of about 19,000 kw. on the main unit. It was reported that this valve could not be closed under this condition with the original motor equipment. More powerful motors were installed, but the valve still failed to close. Finally, after installing a lower gear ratio, this valve was shut in about 2½ minutes with steam flowing, as stated. Afterward, this valve was opened and the seat rings and disc rings were found to be badly scored.

Since then, in another large power station, where an actual 6-in. break occurred in the turbine room, it was

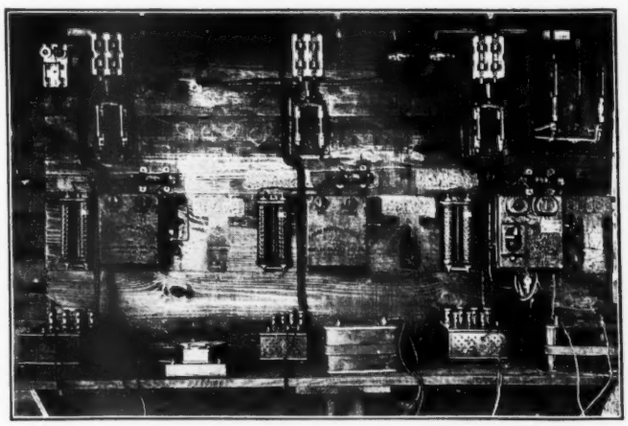


FIG. 2. CENTRAL CONTROL BOARD FOR OPERATING VALVES ON TEST LINE

found impossible to close a 16-in. motor-operated gate valve in the boiler room, and it was some time before steam could be shut off.

N. A. Carle, vice-president and general manager of the Public Service Production Co., Newark, N. J., chairman of the Technical Section of the N.E.L.A. and past chairman of the Prime Movers Committee, became interested in this matter, and arrangements were made with the Public Service Electric Co. to run a series of tests on motor-operated gate valves. These tests were under the auspices of the Prime Movers Committee of the N.E.L.A. with the co-operation of Payne Dean, Limited, who furnished the motor controls and secured the loan of the various valves under test. All the tests were made at the Essex power station of the Public Service Electric Co., Newark, N. J., on Jan. 28, 1922, before a large company of representative engineers, on the following valves:

A. 10-in. cast-steel, monel-metal mountings, globe valve with ball-bearing yoke nut.

B. 10-in. special cast-steel, balanced globe valve, monel-metal mountings with internal bypass.

C. 10-in. cast-steel gate valve with monel-metal mountings, ball-bearing yoke nut and double-disc gate with taper seats.

D. 10-in. cast-steel gate valve with monel-metal mountings, ball-bearing yoke nut and solid-wedge gate with taper seats.

E. 8-in. cast-steel gate valve with monel-metal

mountings, ball-bearing yoke nut and solid-wedge gate with taper seats.

F. 6-in. imported cast-steel, special type single-seated gate valve with nickel trimmings, with internal-hinged disc closing with the pressure.

G. 10-in. imported cast-steel gate valve with outside guides, parallel seats, double-disc gates and mountings of "Platnum" metal.

The first two valves, designated as *A* and *B* in the list given, were globe valves. These were not under test, but were simply installed for protection in case trouble was experienced with the pipe or test valves. The valves

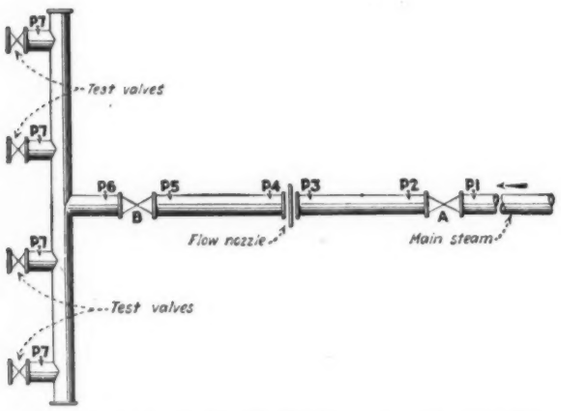


FIG. 3. DIAGRAM OF TEST HEADER AND PIPING CONNECTIONS

under test were five in number, designated *C*, *D*, *E*, *F* and *G*. These valves were installed on the 10-in. high-pressure testing header, as shown in Fig. 1.

It is to be noted that safety anchors were provided on the 6-in. valve *F*, shown on the left, Fig. 1. These anchors were placed on the valve in order to hold it in position should failure occur, as this valve, which is an imported one, appeared to be less rugged in construction than American valves of the same size. Also, the construction of the gate resembled a horizontal-swing check valve, and as this valve closed with the pressure, a breakage of any of the internal links might cause an abrupt closing with consequent damage to the valve or piping system.

All valves were controlled from a central control board located at a safe distance, the arrangement of which is indicated in Fig. 2. The control station at the right of this board was permanently connected to the valve *A* next to the main steam header, while the one in the middle of the board was permanently attached to the second globe valve *B*, Fig. 3, and the control station at the left of this board operated a valve under test. At the conclusion of each test the leads at the valve under test were disconnected and transferred to the next valve that was to be tested. A diagram of the test header and the piping connections to the test valves are shown in Fig. 3. In the actual installation there were three elbows, not shown in the diagram, in the piping between the globe valve *B* and the flow nozzle which measured the amount of steam delivered to the test valve.

A system of graphic recording instruments, all driven from the same motor, was installed, as in Fig. 4. The charts in these recording instruments traveled uniformly at a speed of approximately 6 in. per min. during each test, registering the pressure at seven different points from the main steam header down to the valve under test. These points are marked *P*1 to *P*7 inclusive, on Figs. 3 and 5, with corresponding markings on the recording instruments, Fig. 4.

The middle instrument in the lower row of the test board, Fig. 4, was provided as a spare in case of trouble with any of the other instruments. Also, a recording ammeter, shown at the right-hand of the upper row, was provided and the instrument at the right-hand of the lower row was equipped with twenty pens. Eighteen of these pens were connected electrically to position contacts permanently attached to each valve. These position contacts were spaced ½-in. apart and, accordingly, an exact record of the time taken by a valve under test to reach any point was recorded. The nineteenth pen on this indicator was connected electrically to a contact on the control switch on the main board operating the test valve. Consequently, a record of exact time of closing and opening of the test-valve control switch was taken.

As a further means of securing a record of the time, the twentieth pen on this recorder was connected to the push button *C*, shown just below, and during each test this button was pushed every ten seconds. As a further check indicating test gages were installed on the lines leading to the recording gages, and simultaneous readings of these gages were taken by observers during each test.

The design and installation of the test instrument board was made by the Testing Laboratory of the Public Service Electric Company.

In testing the gate valves, steam was admitted from a 22-in. main header to which the 10-in. testing line was connected. Eight B. & W. cross-drum, water-tube boilers each of 12,780 sq.ft. of water-heating surface, and equipped with underfeed stokers, were used during this

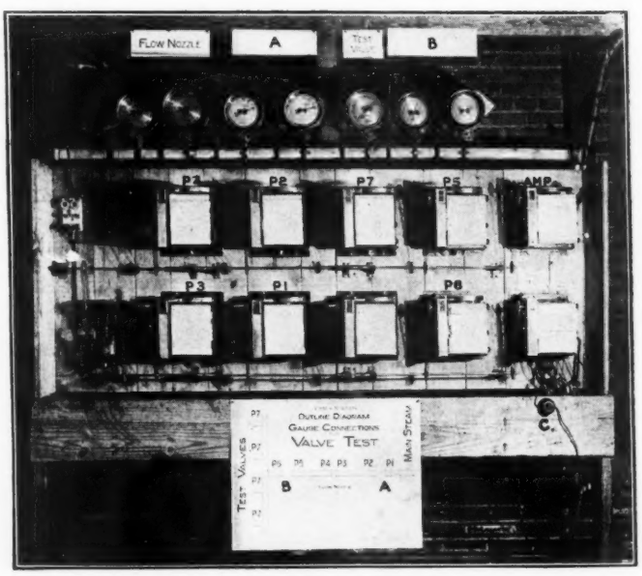


FIG. 4. ARRANGEMENT OF GRAPHIC INSTRUMENTS USED FOR OBTAINING A RECORD OF TESTS

test. In order to maintain full boiler pressure of 225 lb. and 150 deg. F. superheat with free blow to atmosphere through one 10-in. opening, it was found necessary to operate these boilers at approximately 150 per cent of rating. As these boilers are designed for a maximum capacity of about 300 per cent, no difficulty whatever was experienced in supplying sufficient steam.

Fig. 5 shows the graphic record of the pressures at the various points during one of these tests. The maxi-

mum steam velocity on this one test was approximately 27,600 ft. per minute. Almost all of the gate valves under test were somewhat special, in that ball-bearing yoke nuts were provided. Also, the motors installed were extremely powerful in order to make certain that

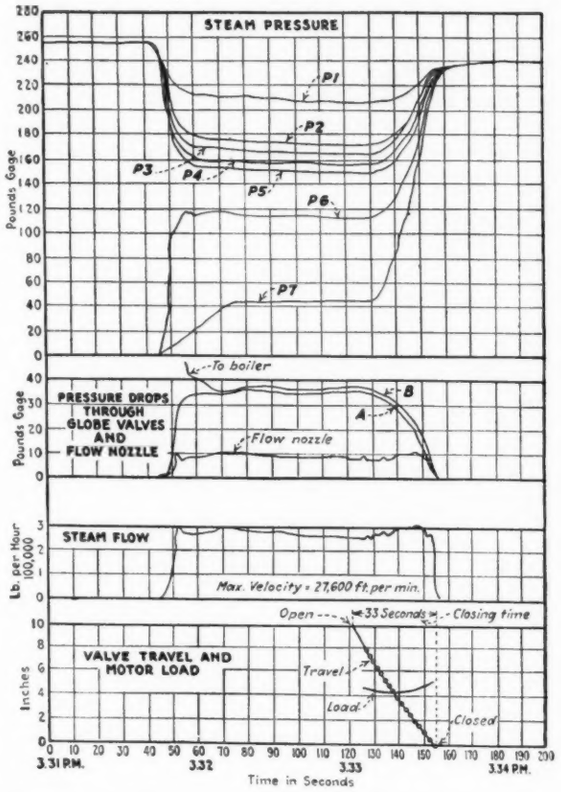


FIG. 5. GRAPHIC RECORDS OBTAINED OF ONE TEST

sufficient power would be available to close the valve under all conditions, which required about 1,200 watts.

The test showed that in this size of gate valve closing can be expected with a sufficiently powerful motor under emergency conditions. Consequently, in case of failure in a main steam header in a large boiler house, should any of the large valves jam in closing, the flow of the steam can be controlled from the main stop valves on the boiler leads.

Inspection of the valves after test showed some scoring of the seat and disc rings on one of the solid-wedge taper seat valves and considerable scoring on one of the double-disc gate valves. This scoring apparently occurred at the exact moment of closing, and seems to indicate the desirability of machining the interior guides so as to prevent the disc from dragging across the seat before the valve is entirely closed. The guides in this particular valve were not machined, which apparently permitted the disc to drag on the seat and damage the valve. There is considerable doubt as to this valve's satisfactory closing in case of a second trial, due to the damage to the seat and disc rings. At some future time further tests may be conducted on larger valves to see if any further changes are desirable.

This test seems to indicate the desirability of providing the entering sides of the valve discs with rounded edges, so as to reduce the possibility of seizing to a minimum, also that carefully designed and machined guides should be provided to prevent the discs dragging across the faces of the seats.

Compound for Preventing Commutator Troubles

Probably 90 per cent of the attention that must be given to direct-current machinery is to the commutator and brushes. If sparkless commutation can be maintained, satisfactory operation of the machine is practically assured. Developments in both machine and brush design during recent years have done much to eliminate commutation troubles so prevalent with the earlier types. However, there still exist many cases where careful attention is required to keep the sparking at the brushes within the limits that will insure satisfactory operation of the machine.

There has recently been developed and placed on the market by the Electro-Maintenance Co., Philadelphia, Pa., a commutator compound, which, when applied to the commutator, has been successful in preventing sparking, burning and ring fire. This compound is not a lubricant and will not gum or collect on the brushes and brushholders as will vaseline or other lubricants. It may be used on either flush or undercut commutators without danger of causing short-circuits. Applications are made while the machine is running and while two or three treatments a week may be necessary at first, after a short time these may be reduced to once a week. The compound may also be used to prevent cutting of switch and controller contacts. Some grades of carbon brushes have shown improved commutating qualities when treated with this compound. It is made for different voltages ranging from 5 to 500.

Dual Flow Steam-Driven Air Compressor

The steam end of the dual-flow steam-driven air compressor, Fig. 1, is designed on the unaflow principle. The exhaust steam leaves through a port in the center of the cylinder which is uncovered by the piston when

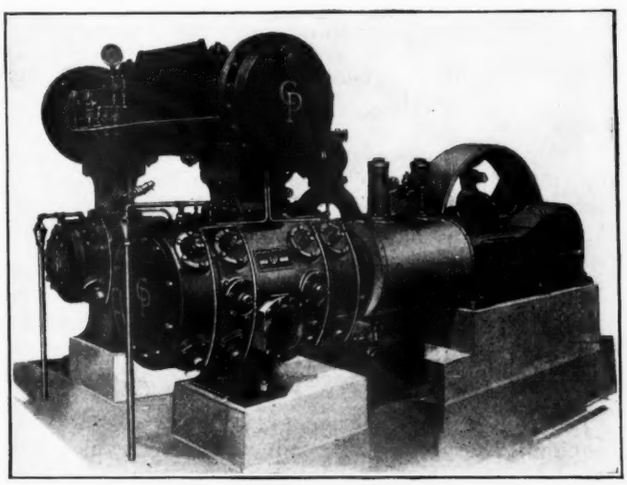


FIG. 1. AN EXTERIOR VIEW OF THE UNIT

the latter has traveled about one-half its stroke. The exhaust is controlled, however, by a poppet valve, which opens when the piston is near the end of its stroke and closes again (if the machine is running noncondensing) when the piston covers the port on the return stroke. When running condensing, the valve closes early in

the return stroke. Compression does not begin until the piston has traveled half the return stroke.

The valves adapted (see Fig. 2), are of double-seat poppet type for both admission and exhaust. Inequalities of expansion of the metals forming the valve and seat due to different co-efficients of expansion, are compensated for.

This compressor, which is manufactured by the Chicago Pneumatic Tool Co., 6 East Forty-fourth St., New York City, operates at a constant speed and shows the best steam economy when operating at its greatest

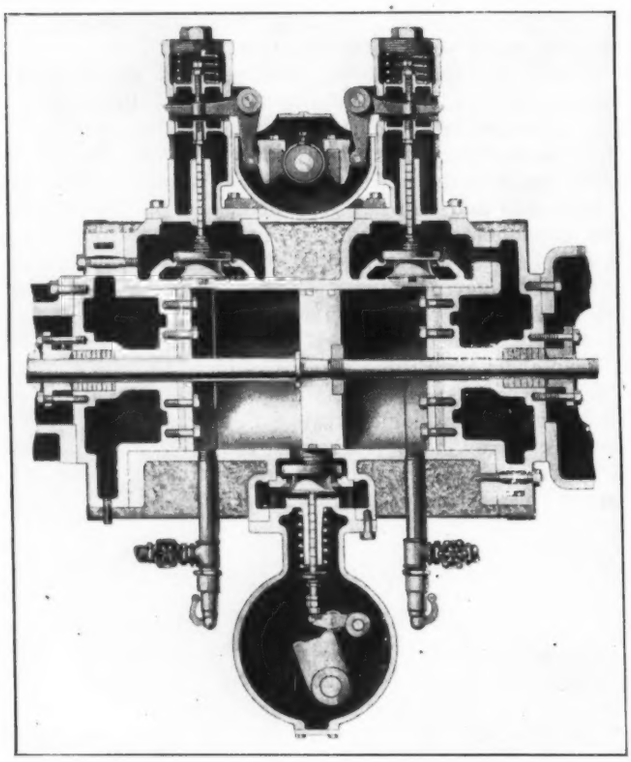


FIG. 2. SECTIONAL VIEW THROUGH THE STEAM CYLINDER

speed. Regulation is effected by two-step capacity control; two differential unloaders connect with the inlet valves and reduce the capacity of the compressor in two steps. One unloader holds open the inlet valves on the crank end of one cylinder and the head end of the other; the second unloader holds open the inlet valves at the opposite ends. The air valves are of the "simplate" independent disc type.

Getting Capacity Out of a Run-Down Refrigerating Plant

BY D. L. FAGNAN

The following experiences, when read by the younger generation just coming into the ranks, will no doubt help them through when up against a run-down plant, and the old men will smile while reading and will acknowledge that practically the same thing happened to them at some time or other. But they somehow pulled through just as the writer did.

In the year 1898 I took charge of a plant containing a 50-ton Arctic ice machine. The plant was run down at the heels, the boiler was dirty, the coils leaked, and the condenser was so full of defective joints that it seemed impossible to keep a charge of ammonia in the system. The daily output was from 18 to 20 tons of ice when it should have been 50 tons.

By going thoroughly over the condenser, taking up all joints that had any rubber gaskets left behind them, and renewing gaskets where they were missing, giving every joint in the line the necessary tightening, we were enabled to keep a decent charge of ammonia, in the system. Next, by taking down both crankpin bearings, which were giving no end of trouble through heating, and scraping the brasses, cutting oilways and cleaning, we increased the speed of the compressors sufficiently to bring the output up to 30 tons a day.

The old-style regulating valves (expansion valves) leaked so badly as to allow the suction line to freeze back solid to the compressor. Some of the valves connected to other coils needed to be opened wider but could not, owing to the heavy frost that covered the valves. The only way that we could operate was to run for an hour, then shut the main liquid valve and pump down for fifteen minutes. Then, by opening this valve again, the flow of liquid was started. After two weeks of this we shut the plant down one Sunday, and after inserting a special rubber plug below the valve seat to prevent any air entering the coils during the reseating process, we were able to reseat the valves and put them into proper working condition. Upon starting up the improvement was quite noticeable, since the tonnage jumped to 33 tons a day, and even with this output we could slow the machine down a few revolutions.

The boilers were next looked into and were found in a terrible condition. The brickwork was in bad shape, the side and back walls being badly cracked, and the combustion chamber arch was practically all gone. By working night and day, we finally cleaned the boiler of scale and repaired the brickwork. The owners were induced to put in shaking grates, and with the overhauling given the boiler, the whole plant could be operated at full load with one boiler cut out.

The fuel consumption had previously been 5½ tons, and with the boiler fixed it dropped to 5 tons, and the brine pump and other equipment had not been touched. After overhauling the brine pump, packing the valves in the steam line and cleaning the reboiler, the coal consumption dropped to 4½ tons, and the output of ice was twice what it had been in the past. The owners were much pleased with the results, but when I asked them for a raise they got cold feet. They stated that I had come to work for a certain salary and it was expected that I would do my best. Consequently the fact that in doing my duty I had been able to save them so much money, and increase their output, was nothing but what could be expected. They lost sight of the fact, however, that I had been working 21 hours out of every 24 for sixty or seventy days. Consequently all I could do was to look for a more promising job and leave this plant to the mercies of someone else. About a year later I dropped in to the plant and found the old conditions again in existence.

The Bureau of Engineering of the Navy Department reports that by a change in the machinery on battleships and destroyers a great saving of fuel oil is possible. Evaporators that have been operated under high steam pressure are being converted to low-pressure double-effect operation, using exhaust steam. This change makes a saving of eight to ten tons of oil a day on a battleship and approximately three tons on a destroyer.

Central Heating by Steam, Water or Gas

By SAMUEL R. LEWIS*

WHETHER to adopt steam, forced hot water or producer gas burned under automatic gas-fired cast-iron boilers for the heating of a group of university buildings has been the subject of a recent investigation resulting in the recommendation of the gas plant and the adoption of the plan by the trustees for eventual execution.

Substantial contributions had made possible an increase in the number of buildings, and several new ones are now under way. On a campus extending over 200 acres there are fifty-five buildings existing and projected, not counting future residences for the faculty. A high-tension electric transmission line passes near-by.

It was necessary to eliminate from consideration a central heating-plant system on the campus proper, as the haulage of coal and ashes through the village and over the campus would be objectionable. The class and dormitory buildings, numbering forty-seven out of the total of fifty-five mentioned, must have central-station service. The other buildings, which are large chapter houses and residences, should have it. A plant of some 2,000-hp. capacity will be needed, and the transmission lines will total about 10,000 ft., including the main from a power house at the railroad. The plant is to be designed so that it can be built in sections to serve the successive buildings as they are needed, so that great flexibility of the transmission system is necessary.

Central producer-gas plant with automatic gas-fired boilers in each building shows an estimated saving in initial investment of $173,000 and a reduction in annual operating expense of $14,700 over steam heating.

While a high-tension electric service line is near, it may be deemed advisable to generate electricity. The dormitories and gymnasium must have hot water, and cooking facilities should be provided throughout the year, and these services must be available for economical operation twenty-four hours a day the year round. Many of the buildings need not be heated all of each day excepting to prevent freezing.

An analysis of the preliminary plans shows that for fifty-five buildings the coal consumption, with a boiler efficiency of about 65 per cent, will amount to 5,200 tons per season of two hundred 14-hour days, and a maximum of 7,000 lb. in any hour. On the basis of 60 cu.ft. for each square foot of radiation for dormitories, gymnasiums and the like, and 40 cu.ft. for each square foot of equivalent direct radiation for buildings that require mechanical ventilation, such as classrooms, library, laboratories, etc., the load is 188,000 sq.ft. of direct steam radiation. Transmission losses when the lines are in perfect order, with no leaks, will require 650 tons of coal during the heating season in addition to that for the buildings. This figure is based on a heating season of 200 days, of twenty-four hours each, since the tunnels cannot be allowed to cool so much during any part of a day so that the reheating cost will exceed the maintained heat cost.

With hot water or steam heating, therefore, the transmission loss, under the most favorable conditions, amounts to about 11 per cent of the total fuel when heating the buildings, to say nothing of the losses for stand-by service for buildings like the gymnasiums, used intermittently. There will be serious losses also in the transmission of heat for service water, cooking, laundry purposes, etc., which from experience are unaccountably high.

Allowing 2,600 ft. as the distance from the power house at the railroad to the tunnel in front of the chapel, the university will require about 10,000 ft. of tunnel. The size will vary from 10 ft. wide to 7 ft. wide and 7 ft. high inside. The steam mains would range from 12 to 2 in. in diameter, with an average return of about 6 inches.

Allowing for some rock excavation, using 6-in. reinforced-concrete walls and double-thick magnesia insulation, the tunnels will cost on the average not less than $35 per linear foot complete, at present prices. This gives a total of $350,000 for transmission lines and is not far out of the way, as the first 2,600 ft. of 10-ft. tunnel from the power house to the chapel will cost about $120,000.

In Table I the cost of the boiler house, individual plants in the buildings and of operating labor may be fairly ignored, since that would be the same as with the type of central heating next to be considered. The estimates are based on the simplest possible sort of plant, without electric generation, and with ash and coal handling by an elevator and push-cars. No mention is made of service-water heating, since the cost would be somewhere near the same with any kind of plant. The upkeep will total easily 5 per cent each year on the machinery, mains, etc.

To better fulfill the requirements at a lower cost, it is proposed to install a producer-gas generating equipment at the railroad, with ordinary gas mains running to each building and gas-fired automatic cast-iron boilers in each building to do the heating with steam or water, as the type of service of each may suggest.

A gas plant will require a large supply of cooling water. This is available from a near-by creek. It will require a chimney and steam boilers. These can be placed at the railway location without prejudice. The producer-gas plant will require no greater labor expense or housing expense than the hot-water or steam plants.

It will be necessary to provide a boiler in each building or perhaps in each group of buildings. The cost of these, however, will be offset to some extent by the saving of pressure regulators and traps required by a steam plant. Some attendance and supervision by engineers and janitors in each building would be necessary with any type of plant. Automatic gas-fired boilers require as little attention as any conceivable apparatus that could be placed in so large an institution.

With gas, unlike hot water or steam, the usual difficulties due to a constantly increasing load inherent to most public plants are not encountered. All the buildings can be cared for, and the more the load the less the unit cost will be.

*Of Lewis & Capron Co., consulting engineers, Chicago.

Since there will be practically nc transmission loss, heat for summer uses can be furnished from the large gas distributing mains, and the gas generators can be operated in proportion to the load, whatever that may be, by having several units of varying capacity. There will be no tunnels or insulation. Cast-iron pipes buried in the ground can be used. Several of these, side by side, can be installed as the load grows, at little additional friction, thus keeping the investment reasonable proportioned to the load. Electricity can be generated with gas engines at a comparatively low unit cost.

Producer gas is comparatively bulky. About four times as much of it is required to do the same heating service as with natural gas. It is clean, however, and can be used for cooking as well as for heating, and can even be used for illumination when Welsbach mantles are installed. It is not practicable to store it in holders, on account of its bulk.

Small Generating Plant Desirable

With the gas plant it may be desirable to install in the power house a small electric generating plant, gas-engine driven, for power purposes in running the various pumps, fans, etc., particularly as the heaviest lighting load will come during the evening, off the peak heating load.

Since the boilers will be small, well insulated and in fireproof compartments, there need be no more apprehension on account of fire or explosion with the gas plant than with high-pressure steam or with hot water.

No byproducts from the plant have been proposed except such as will be carried away by wind and water. The tar is redistilled and eventually is all gasified. There will be some odor of ammonia from the cooling tower, but the plant as located will be so far removed from any other building that this possible objection will not be valid. As the products of combustion from the gas heaters in the various buildings will carry a considerable water content, chimneys serving them should have cast-iron linings.

The gas-distributing system should be designed for an initial pressure of 1½ lb., a careful analysis having demonstrated that the exhaust steam from the gas pumps will be just sufficient at this load, to furnish the requirements for steam injection into the gas producers. The gas pressure at the entrance to buildings should be one-half pound.

Producers do not respond as readily to overloads as do water-tube boilers, but units can be designed of such

TABLE I. ANNUAL CHARGE FOR A STEAM PLANT

Fuel (5,850 tons at $6)		$35,100
Transmission lines, cost	$350,000	
Boiler plant, 20,000 sq.ft., including auxiliaries	100,000	
	$450,000	
Interest and sinking fund, 10 per cent		45,000
Upkeep on boilers and piping, 5 per cent of $200,000		10,000
Annual Cost		$90,100

flexibility that the plant will furnish just about the right amount of gas each hour, without overloading. The larger the plant and the more varied the kind of buildings served, the more favorable will be the load factor. It is not impracticable for arrangements to be made so that the heating of large intermittently used buildings, such as gymnasiums, and the heating of swimming pools, shall serve as an equalizer, the equipment in such buildings floating on the gas line and taking gas only when the pressure is ample, thus reducing the peaks.

The gas plant would consist of three gas generating, cleaning and pumping units, each capable of supplying approximately 230,000 cu.ft. per hour. To supply steam to the engines driving the gas pumps, a steam boiler plant of 3,000 sq.ft. would be required. The boilers and gas-generating plant would be housed in one building for convenience of supervision and operation. Mechanical coal-handling would be required on account of the height to which it is necessary to raise fuel to the producer coal feeders. This coal-handling plant would be extended to supply coal to the boilers, thus reducing manual labor.

As the regulations of the State Board of Health prohibit the disposal of gas-works wastes into public

TABLE II. ANNUAL CHARGE FOR GAS PLANT

Fuel (6,057 tons at $6)			$36,342
Transmission lines (gas mains)		$50,000	
Producer plant			
Three 14-ft. producers	$106,000		
Three 1,000-sq. ft. boilers	15,000		
Pumps and cooling towers	15,000		
Piping	7,500		
Foundation and tank	8,500		
		$152,000	
Excess cost of boilers in the various buildings over regulators and traps		75,000	
		$277,000	
Interest and sinking fund, 10 per cent			27,700
Upkeep on plant and boilers, 5 per cent of $227,000			11,350
Annual Cost			$75,392

waterways, it becomes necessary to keep all waste water in the plant. This would be provided for by the installation of a suitable tank for settling tar from the water, from which the water would be pumped to a cooling tower, then returned to the system. A certain amount of makeup water would be required, which would be supplied from the adjacent creek. The tar settled from the water would be returned to the gas producers and there converted into gas.

With a high-grade producer plant of the size required, an efficiency of 75 per cent from coal to cool clean gas delivered at one pound pressure is readily possible and with gas heaters for steam or water, the writer has verified an efficiency of 80 per cent from gas to steam.

Heat Losses from Buildings

The total heat loss from the buildings, on which the coal requirements for the steam plant were based, is 47,000,000 B.t.u. per hour. At 75 per cent efficiency of the gas boilers and 75 per cent efficiency of the gas producers, 5,200 tons of coal per season of 200 days would be required. In addition to this fuel consumption for the gas plant coal must be burned for the gas pumps and the exhaust steam used in connection with the process. This power demand adds 857 tons of coal per season, or a total for the gas plant of 6,057 tons.

Comparing Tables I and II, the annual charge for the gas plant seems to be some $14,700 less than that for the steam plant. For plant investment it will be much easier to raise $277,000 than $450,000. Unless these figures deceive, an exceptionally inefficient gas plant would be permissible so long as good heating service was rendered. The following comparison is interesting:

Annual cost of steam plant	$90,100
Cost of gas plant without fuel, being merely the overhead	39,050
	$51,050

The difference between these two items is $51,050, being what is left to buy coal for the gas plant from a steam-plant appropriation. This would buy 8,508 tons at the $6 price, or nearly half again as much coal as the gas plant will require.

EDITORIALS

Railway Rates and Coal Purchases

ANTICIPATING a strike in the bituminous coal mines the first of April, many are advising that industry lay in an ample supply of coal to tide over any such period of disturbance. Offsetting this is the argument that freight rates on coal may be considerably reduced as a result of the hearings now in progress before the Interstate Commerce Commission. Thus there are two conspicuous but conflicting tendencies presented to confuse the coal buyer.

Whether the coal miners will strike or not is a question beyond the wisdom of the most careful student of the subject. It is doubtful whether even the leaders of the United Mine Workers themselves know with any degree of confidence just what their organization may be willing to undertake when April first arrives. Undoubtedly, the union miner whose grievances have been aggravated greatly by lack of work during the last year is in a frame of mind to fight bitterly for his cause when the wage agreements are under consideration this spring.

On the other hand, the union mine worker has had the most distressing experience during the past season of being idle for considerable periods, while non-union bituminous fields have been working at almost normal capacity. Thus it may be that the union miner will not be prepared to go so far as his leaders would have one think. He may feel that an extended strike this spring will simply play into the hands of the non-union workmen, who presumably will not join in such strike, at least on a general scale.

As to railway rates there is no doubt as to the effect of any decision of the Interstate Commerce Commission during the next few months. The Commission may later reduce coal freight rates somewhat, for these rates now take, by and large, half of the total "delivered cost" of the coal, but it is practically impossible for the commission to change coal rates generally so that they would take effect before April first, the date of the threatened miners strike. Therefore, this factor can be eliminated from the question whether to buy coal now.

In any industrial plant where interruption of coal delivery for a short period might mean either closing down or serious increase in cost of operation, it behooves the management to be prepared against the threatened strike. The insurance against such interruption, even at a slight increase per ton in the price of coal, would be purchased cheaply. Unless there should suddenly develop a strong upward trend in coal prices, because of a general movement toward coal purchase, it seems good advice, therefore, to recommend immediate attention to the coal stock. A considerable extension of coal purchase beyond the average rate for the past few months certainly could be met by producer and transportation agencies alike without causing any serious likelihood of a runaway "bull" market for coal.

Proper Instructions Imperative

MOST manufacturers of power-plant apparatus have always felt the need of some effective means of instructing the operators how to take care of the machinery when it is turned over to the purchaser. This need, instead of becoming less as machinery is more widely used, seems to have become greater during the last few years. Particularly is this true since the beginning of the World War. During the war period great numbers of experienced and well-trained operators of machinery left their usual occupation and their places were taken by men who were not familiar with the machinery they were called upon to handle.

As might have been expected, an unprecedented amount of trouble was experienced with machinery that previously had given excellent service. The attention of manufacturers was drawn to the fact that in certain classes of installations continued trouble occurred with a particular line of machines, while in other installations no trouble at all was experienced with the same class of machine. Investigations of apparatus failures frequently revealed the fact that the operators knew scarcely anything of the machines, and that the trouble was due to such mishandling as a well-trained operator would never be guilty of.

As an illustration the governor valve of a turbine was rendered inoperative by an accidental bending of the stem at the point where it passes through the gland. This condition was perfectly obvious to anyone familiar with such a machine, but the operator did not notice it, and when starting the machine overspeeded and the emergency overspeed device shut the throttle valve. The operator believed this to be evidence that the overspeed device functioned at too low a speed, although he did not know what the speed was. He set the overspeed device so that it would not go off at so low a speed, but did not try to find out the speed at which it would operate. When the throttle valve was reopened, the overspeed device operated and shut the turbine down. Next, it was decided that there must be something hopelessly wrong with the overspeed device, so it was disconnected and the turbine again started, with the result that the machine was wrecked.

It is almost incredible that the operation of a machine of this kind would be entrusted to anyone who would not take steps to find out what was wrong with the main-speed regulating governor when the emergency overspeed device had operated the second time, or who would not even check up the speed before rendering the overspeed device inoperative. This is but one of many equally foolish things that have been done during the last few years, and very forcefully emphasizes the necessity of properly instructing the operator as outlined in the article, "Instructing Power-Plant Operators," by J. A. MacMurchy, in this issue. Properly instructing the operator can probably do more toward preventing trouble in the operation of power-plant equipment than any other single factor.

Heat Balance in Small Plants

AN ABSTRACT of papers dealing with heat balance, presented to the American Society of Mechanical Engineers, was recently published in *Power*. These papers, while of great interest, treated the subject from the viewpoint of the large power plant only. Naturally, the question arises: "How can the engineer responsible for a small condensing power plant maintain the best heat balance?"

The answer to this question is less difficult if heat balance be defined as "the operating combination which produces the power output of the plant with the least possible waste of heat and the least possible expenditure of coal." The coal pile is the ultimate measure of plant operating efficiency. Hence all improved methods of burning coal and transferring its heat into steam tend toward higher over-all efficiency. These methods are continually being discussed in these columns and need not be enlarged upon at this time.

It may frequently happen that the plant is not making the most effective use of the heat in the steam after it leaves the boiler. In other words, the heat balance may be capable of improvement. This presents a difficult problem in determining what combination of main units and auxiliaries gives the least over-all heat consumption or what equipment might be changed or improved to give a less consumption of heat.

The feed water in every case should be heated to that temperature that gives the least heat consumption for the plant. This is not always the highest possible temperature, for at the Connor's Creek plant of the Detroit Edison Co., where a barometric condenser type of feed-water heater is used, this temperature was found to be about one hundred sixty degrees Fahrenheit. In many small plants, however, open heaters at atmospheric pressure are used. Efforts should be made to keep the feed temperature as near two hundred and twelve degrees as possible in such plants. Frequently, the open heater is too small for the service or poorly arranged for obtaining the best heat transfer. The saving in coal that a new and more efficient heater could effect would frequently pay the greater portion of its cost in the first year. The heat-insulating covering of heaters is often allowed to get in a dilapidated condition, causing large losses by radiation. In fact, all pipe covering should be kept in first-class condition at all times.

If there is insufficient steam to heat the feed water to, say two hundred ten degrees, when no economizers are used, the engineer should study his plant carefully to determine whether certain auxiliaries that are motor-driven might be steam-driven to provide more exhaust steam for heating, or whether additional load may be transferred to the steam-driven auxiliaries already in service.

Frequently, it is the case that exhaust steam is available in greater quantities than needed to heat the feed water and is wasted to the atmosphere. Obviously, this represents a heat loss and an unfavorable heat balance. The engineer in that case must endeavor to provide additional motor drives or to transfer load from the steam-driven unit until no steam is wasted.

One small turbine plant built a few years ago for an industrial concern was provided with a duplicate set of steam-driven exciters which were considerably larger than needed for excitation alone. Certain of the auxiliaries were motor-driven, while others were steam-driven. Lighting transformers for adjacent parts of the mill were placed in the engine room. An additional panel of the switchboard was provided with double-throw switches so that any part of the lighting load, which was heavy, could be thrown from the exciters to the main unit, or vice versa. An indicating thermometer from the feed-water line was also placed on this panel. The operator, by adjusting the load between steam- and motor-driven auxiliaries, together with the final adjustment of lighting load, was thus able to maintain a favorable heat balance at all times.

Maintenance of traps in first-class condition, recovery of all drips, and the reduction of radiation losses to a minimum are also essentials of a favorable heat balance. Hence, studies of heat balance should not be confined to large plants, for there are many interesting problems and as great possible relative savings in the small plants.

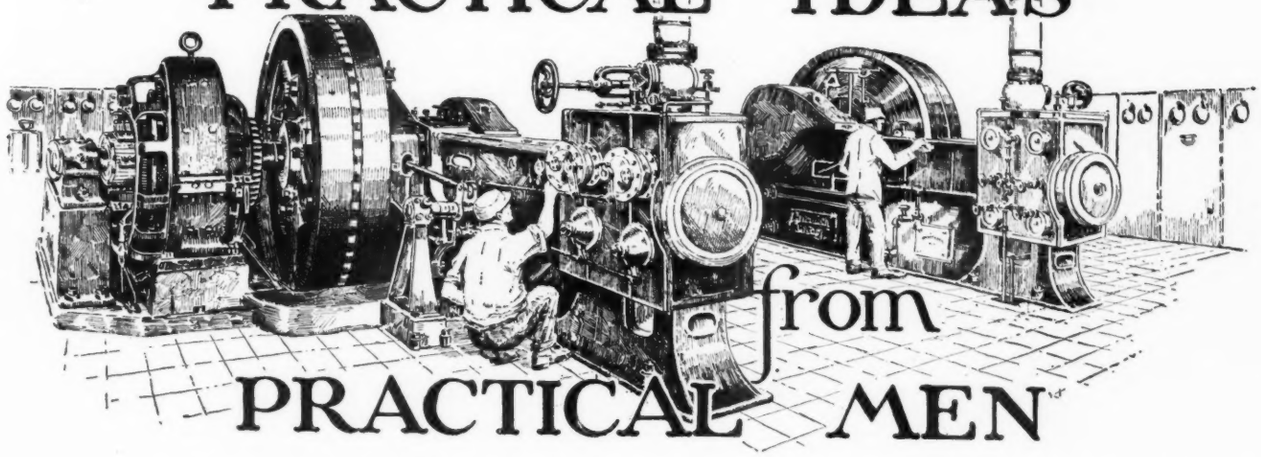
That the Government's Fuel Yard at Washington constitutes an unwarranted interference with private coal dealers and fails to save the Government money are the "arguments" advanced recently before the House Committee on Mines and Mining, by Roderick Stephens, of the National Retail Coal Merchants Association. The committee is considering acquisition of the Fuel Yard site, which is now leased by the Government. The coal men have accused the Government of going into business in competition with them, whereas it is simply buying coal at wholesale for distribution to its departments in Washington instead of leaving them at the mercy of dealers who now miss the profits that they formerly made on Government sales. And as for their solicitude that the yard is not economical, it seems more suitable to leave determination of that to the Government, which is hardly likely to continue an unprofitable enterprise out of spite.

There is a decided tendency on the part of some employees to disregard safety rules and regulations. In fact this goes so far that some look upon these rules as an infringement upon personal liberty. Persons who take this attitude, either through ignorance or otherwise, have no regard for their own safety or that of others, and should not be tolerated in industry. If they cannot be made, by reasonable persuasion, to appreciate and work in sympathy with safety-first ideas, their discharge should be the penalty. The present toll of human life, personal injury and destruction of property is too great to deal lightly with the heedless, those who are responsible for about eighty per cent of this loss.

In industry there are two classes of loafers, the employee who shirks his work, and capital that is not represented by some tangible assets—in the vernacular of the trade, "watered stock." Both are parasites; which of the two is the worse it is hard to tell; they both take their toll from the honest conscientious workers' efforts. When we are able to eliminate both from industry, a real advance will have been made.

Present conditions are frequently being painted unduly black. Eighty-five per cent of the people in the United States are at work and are being paid at a relatively higher level than at any previous time in twenty-five years. Wages and salaries have not fallen with the average price level. Savings banks show a higher level of deposits than ever before. Unemployment exists, but not to an alarming extent.

PRACTICAL IDEAS from PRACTICAL MEN



A Suggestive Incident

There is a 14 x 36-in. engine in my plant that is loaded to the limit, driving an 85-kw. generator. If there were any practical way for increasing the power of this engine, I would adopt it. Several times I have read the statements of writers who recommend that adjustments be made to lengthen the point of cutoff for a given position of governor, without taking further precautions.

Today this engine was carrying a full load, when suddenly the circuit breaker went out, thus throwing off the whole electrical load. The governor balls at once rose to a higher plane, the cutoff was shortened almost to zero, and the engine continued to run at normal speed.

Suppose that I had followed the directions mentioned and when this load was thrown off, the cutoff had been shortened as much as possible but owing to the lengthening process the shortest cutoff that could be secured, was, say, 4 in. A flywheel explosion might have occurred.

Whenever any adjustment of the cutoff that is controlled by a flyball governor is made, the following test should be applied: With the highest steam pressure that can be carried and no load on the engine, raise the flyballs to their highest position. If the engine slows down and stops, the adjustment is safe. If it continues to run, the cutoff mechanism is in a dangerous condition and should be made safe at once.

New Haven, Conn. W. H. WAKEMAN.

Mechanical Stokers and Small Steam Plants

The question frequently arises, Does it pay to stoker a plant of one, two or more small boilers? It is not unusual to hear the remark that there is no advantage in stokering a plant of 10,000 sq.ft. of heating surface or less. Just why 10,000 is selected as a minimum, seems unexplainable in the minds of those who express an opinion on the subject. Nevertheless, it seems to be considered by many as the turning point. Undoubtedly there are many more small plants unstokered than stokered, chiefly because most of them are "one-man" plants. The original investment is often the determining factor. "What good is there in buying stokers if just as much labor is required?" is a pertinent inquiry.

The labor item is probably the determining element and gives rise to the assumption that no gain results from stokers in the usual small plant. Another thing, the small plant is generally a necessary adjunct to the principal product of a factory and represents a small proportion of the cost of the finished article. For instance, in the manufacture of cotton cloth, steam and power may mean one-eighth of a cent per yard of goods produced, which sell for only sixteen cents per yard, or, as in the production of paper, may represent but $6.50 per ton of finished product.

This insignificant amount puts the steam plant in the background as an important element in the cost of production, and consequently it is often lost sight of as a factor requiring the expenditure of any more than just sufficient to keep it going. This attitude may be justified if such a steam plant runs continuously, without shutdown, during the working hours of a factory, but seldom is this the case. A shutdown may and usually does involve considerable loss. A boiler of a single battery may have to be cut out, and with the usual firing methods the remaining boiler can assume but about 25 per cent of the load dropped. The loss is taken in reduced production, the actual earning capacity of the factory is affected, and the cost of production rises in proportion to the idle equipment and labor, which does not cease coincidently with an unexpected shutdown.

No hand-fired boiler can compare in general average efficiency with a stokered boiler properly proportioned and installed. There is, therefore, always the possibility of a saving in fuel, varying from 5 to 15 and often 20 per cent. The item may be small, in a small plant, but it is often sufficient to pay the fireman's wages.

A stokered boiler is capable of being operated at much higher overloads than is possible with hand firing. A fireman may, by exerting himself, maintain 25 per cent overload, and reach a maximum of 50 per cent, but for sustained overloads of 100 per cent he would be in difficulties.

A suitable stoker installation would enable such overload conditions to be met easily, and would insure the continuance of a normal factory load without interruption, even if conditions arise, requiring the cutting out of a boiler of similar size.

Many small steam plants might equip with mechanical stokers and save the cost of additional boiler capacity, due to growth or increased load demands for a period of some duration, but such a course of action is

limited by what may be consistent with sensible engineering and conditions of the plant and equipment.

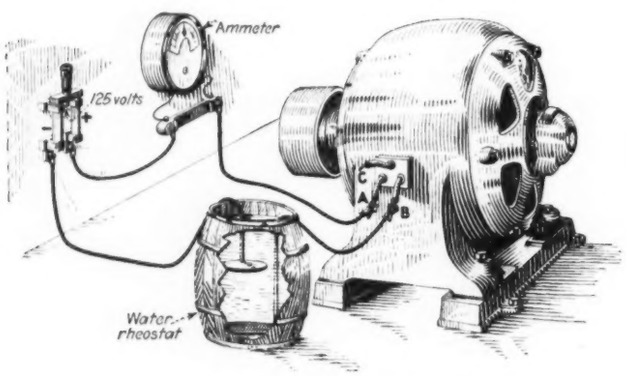
There is no good reason why every steam plant, small or large, cannot be made the subject of intelligent study, and without question many would be greatly benefited by a proper stoker equipment. No boiler is too small to give the question consideration, as conservation of fuel alone is sufficient to warrant an investigation. There can be no definite line drawn as to size of the plant in which stokers would be of an advantage; it is rather the question of results to be derived from stoker equipment in each individual case. H. E. OSGOOD.

Sanford Riley Stoker Co.,
Worcester, Mass.

Drying Out a Three-phase Motor with Direct Current

A 75-hp. 2,300-volt three-phase motor direct-connected to a centrifugal pump became saturated with moisture, due to condensation of vapor given off by the reservoir from which the pump drew the water. This motor is located about 200 ft. from the power station, and the starting compensator is beside the switchboard in the plant, the motor leads being run in underground conduit from the compensator to the motor. It was decided to attempt to dry out the motor by electric heating.

The most convenient source of current for this purpose was the exciter buses on the switchboard. The motor leads were disconnected from the starting compensator and jumper wires run from the 125-volt exciter buses through a water rheostat and ammeter to one pair of motor leads, as indicated in the figure. No changes whatever were made in the motor's internal connections, and the water rheostat was adjusted until the ammeter in the circuit indicated 45 amperes, or about 1½ times full-load current for the motor. Every 30 minutes during the period of heating, the direct-current leads were changed from one to another of



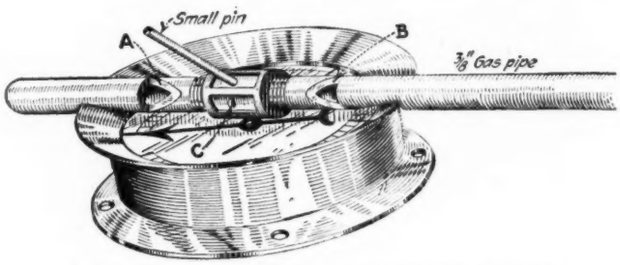
CONNECTIONS FOR DRYING OUT MOTOR

the three pairs of motor leads in rotation; that is, from *A B* to *B C*, then to *C A*, etc. This gave approximately even temperature in the motor. After about two hours' application of the heating current, the motor reached a steady temperature of about 160 deg. F., which was continued for 12 hours, at the end of which time insulation tests indicated that the motor was in condition to operate safely. The machine has since been in daily service with no indications of damage because of its wetting. J. H. BENDER.

Crosbyton, Tex.

Tool for Removing Steam-Gage Glass-Holding Rings

There is perhaps nothing about the plant more aggravating to encounter than the glass ring holder of a pressure gage that has became corroded or set in the fine threads. Because of the thin circular construction



TOOL FOR REMOVING GLASS-HOLDING RINGS

there is no convenient way to grasp it while turning off of the gage casing.

The sketch shows a practical little tool, easily made, with which it is possible to remove the most obdurate ring from several sizes of gages. A right-and-left coupling is drilled with a number of small holes *C*, so that a pin can be used to tighten the grip notches *A* and *B* on the ring. Notches can be cut on the two pieces of pipe to take several sizes of gages.

With this tool sufficient leverage can be obtained to turn the ring without injuring its outer surface.

Missouri Valley, Iowa. FRANK W. BENTLEY, JR.

Engineers Were Unable to Open the Valve

Engineers might be interested in reading the following, which was clipped from the Brookings, S. D., *Register*.

Brookings was left in darkness a short time Tuesday night due to the vagaries of an automatic valve on the new boiler at the power plant. This valve is an emergency device which automatically shuts off all of the steam in case something should go wrong. Tuesday night without any apparent reason this valve shut off the steam and stopped the engine. The engineers were unable to open it and it was necessary to fire the other boiler to keep the engines going.

Wonder what kind of valve it is that "engineers were unable to open." W. F. SCHAPHORST

New York City.

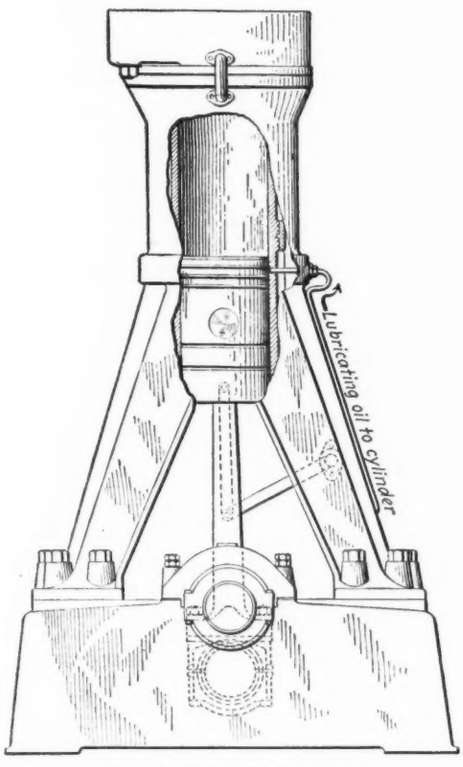
Experiences With the Lubrication of Diesel Engines

One of the chief problems confronting operators of oil engines is that of lubrication. With some designs it is almost impossible to lubricate the cylinder without causing carbon deposits, and if the amount of lubricating oil is cut down to the point where carbon does not deposit, the piston and cylinder walls wear very rapidly. I have been operating a vertical 1,000-hp. Diesel oil engine for some time, and from the experience I have had with this machine, I am under the impression that the manufacturers do not feed the lubricating oil onto the cylinder walls at the proper place.

A diagram of a cylinder with the piston at the bottom dead center is shown in the sketch. It will be noticed that the oil is fed to the cylinder walls at a point slightly below the level of the piston head at bottom dead center. This oil, after entering the cylinder, naturally starts to flow down between the piston and cylinder walls, and the result is that the skirt of the cylinder is lubricated very thoroughly, in fact so much so that a considerable quantity of oil drops down into the crankcase without doing any work. Only a small amount of the lubricating oil adheres to the piston and is carried up along the cylinder walls as the piston moves upward on its stroke. It is obvious that the portion of the cylinder wall toward the combustion end receives but a very small amount of lubrication if any, and this is the point at which the pressure of the piston on the cylinder wall is greatest. Owing to the crank angle and to the high cylinder pressure, it naturally follows that the wear at this point is extreme and permits a serious loss of compression.

In the engine under my care the wear at the top part of the cylinder runs to approximately $\frac{1}{8}$-in., while the skirt shows but little wear, the clearance being from two to five thousandths of an inch at the low end. This wear has taken place during a life of seven years.

After a thorough investigation of the lubrication question and as a result of the experiments carried on



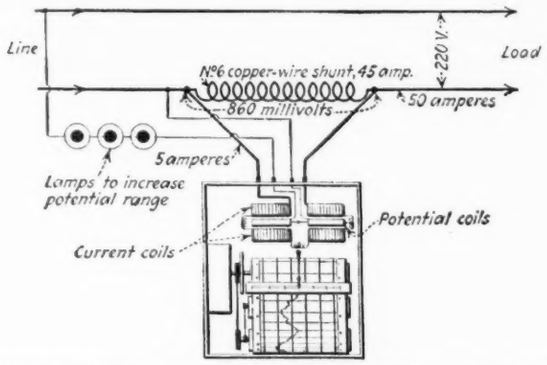
LUBRICATION OF PISTON

with the engine in question, I am thoroughly convinced that the lubricating oil should be fed into the cylinder at a point considerably above the lower dead-center position of the piston head. I would be interested to know what other engineers who have operated oil engines think about the proposition of the proper point of cylinder feed.

Ahmedabad, India. P. P. TALATY.

Operating a 110-Volt Graphic Meter on a 220-Volt Line

An electric-service concern recently received a request to obtain a graphic wattmeter record of a 12.5-hp. 220-volt motor in an outlying district. The tester assumed it to be an alternating-current machine and took along a 5-ampere 110-volt graphic meter with the necessary current and potential transformers. After arriving on the job, he found the motor to be of the direct-current



CONNECTIONS FOR GRAPHIC METER IN MOTOR CIRCUIT

type, taking 50 amperes at 220 volts. However, it was decided to connect the graphic to operate properly if possible.

The only other instruments available were a direct-current voltmeter and a millivoltmeter (ammeter) with several shunts. The first step was to double the potential range of the graphic meter. The 220 volts was impressed on the 110-volt potential circuit of the meter with the millivoltmeter in series, and a reading of 94 was obtained. Then lamps of various sizes were put in series until the millivoltmeter read 48, which doubled the voltage range safely.

The graphic was of the electrodynamometer type which reads correctly on either alternating or direct current, and the current coils were wound for 5 amperes; thus it required a special shunt when operating on a 50-ampere direct-current circuit. Passing 0.5 ampere through the current coil of the wattmeter gave a drop across the coil of 86 millivolts. Then the drop at 5 amperes would be $86 \times 10 = 860$ millivolts. This meant that a shunt must be made which would give a drop of 860 millivolts at 50 — 5, or 45 amperes. Consequently, its resistance must be $R = \frac{E}{I} = \frac{0.86}{45} =$ 0.0191 ohm. In making this test, the millivoltmeter shunt was connected in series with graphic meter, and the millivoltmeter was connected to the shunt while the current was adjusted; then the leads were quickly changed over to the graphic meter's current terminals. In changing leads, *both* leads must be removed before changing; that is, don't move one lead at a time, thus leaving an interval when one millivoltmeter lead is connected to one shunt and the other lead to another shunt or, in this case, to the graphic. Many meters have been burnt out this way. This could have been prevented by a little care.

The only material available to make the shunt from was some No. 6 copper wire. From a wire table it was ascertained that this had a resistance of 0.000403 ohm per foot; so the number of feet required was $0.0191 \div 0.000403 = 47$. About 50 ft. of wire was reeled off and

connected across the meter as shown in the illustration, and the motor started up.

The current was shunted almost exactly as previously calculated, and the graphic needed only a slight adjustment to make it read exactly the same as the product of the volt and ammeters. It was feared that the combination might develop an objectionable temperature coefficient due to the copper shunt, but this was not the case as the slight positive error caused by the heating of the copper shunt was almost balanced by the negative error due to the potential coil. There would have been an error due to a variation in lamp resistance if the line voltage had changed, but this remained fairly constant throughout the whole test. VICTOR H. TODD.

Summit, N. J.

Repairing a Hydrostatic Lubricator

Several years ago I was running a small engine in a planing mill, and before going home at night I always shut off the lubricator and drained it to prevent it from freezing. Once I forgot to do this, and the next morning found the side of the oil reservoir burst about two inches. I removed the lubricator and tried to solder the opening, but it would not hold. Then I soldered on a piece of tin, which held for two days and then started to leak. A friend suggested that I sweat on a patch of copper or brass, which I did, resulting in a tight job.

To most engineers this is nothing new, but it may be of benefit to some of the younger class. First drive the metal back in place around the break with a small hammer, taking care not to mar it. A patch should then be fitted letting it lap about ½ in. all around. The job depends upon this fit. The patch can be made of sheet copper or brass (copper preferred), about 1/16-in. thick or less, as it easy to shape. The patch and the reservoir should be scraped or filed and tinned with solder. Then place the patch over the crack, hold tightly in place with with soft iron wire, and heat with a blow-torch until the solder begins to flow. After it has cooled a little, scrape and polish and the job is complete.

All glasses should be taken out before starting repairs, as the heat might break them. JOSEPH GERBER.

Dansville, N. Y.

What Became of the Bull-Ring Bolts

In the power plant of the Agricultural and Mechanical College of Texas one of the generating units consists of a 250-kva. generator, direct-connected to a cross-compound Corliss non-releasing valve-gear engine running at 200 r.p.m. A few months ago there developed a slight clicking noise in the low-pressure cylinder, which resembled somewhat the sound of a broken piston ring; but upon examination the piston and rings were found to be in good condition, as far as we could determine, and the engine was put back into service, with the clicking noise at the end of each piston stroke still in evidence.

On the morning of Dec. 4 this engine developed a severe pound in the low-pressure cylinder, and it was taken out of service. The cylinder head was removed, which revealed three round holes, about 1½ in. in diameter, in the follower plate of the piston.

The piston and the follower plate was hollow and was made up of three parts as follows: The main part of the piston or casting, a bronze ring 3 in. wide, and a bull-ring follower plate. The bull ring was supported by six 1-in. studs so that this bronze ring could be equally adjusted all around and made to take the wear instead of the piston.

On removing the follower plate but four of these studs were found. Whether the two missing studs were left out in making up the piston or had worked out through the holes made by them in the piston and down into the exhaust pipe is not known, but three of the remaining studs were worn smooth and round, leaving but little trace of the threads on them, while the other one showed but little wear. These studs were put in without a locknut and evidently worked out, one at a time, dropping down inside of the hollow piston, there to be thrown back and forth at each stroke, producing the clicking sound. The follower plate is 1¼ in. thick, and the piston is 32 in. in diameter.

The heavy pound that developed was caused by the last stud working out, which allowed the bronze bull ring to drop down and as the piston was smaller than the ring and therefore smaller than the bore of the cylinder, it was worked up and down at each end of the stroke, causing the pound.

As this engine was badly needed, we simply removed the steam and exhaust valves, plugged up the piston-rod hole, replaced the cylinder head and disconnected the valve gear, and are now running it as a simple engine until another follower plate can be procured.

College Station, Tex. D. E. ADEN.

Condenser Troubles

About two years ago I was sent to locate trouble in a power plant and found the conditions as herein explained:

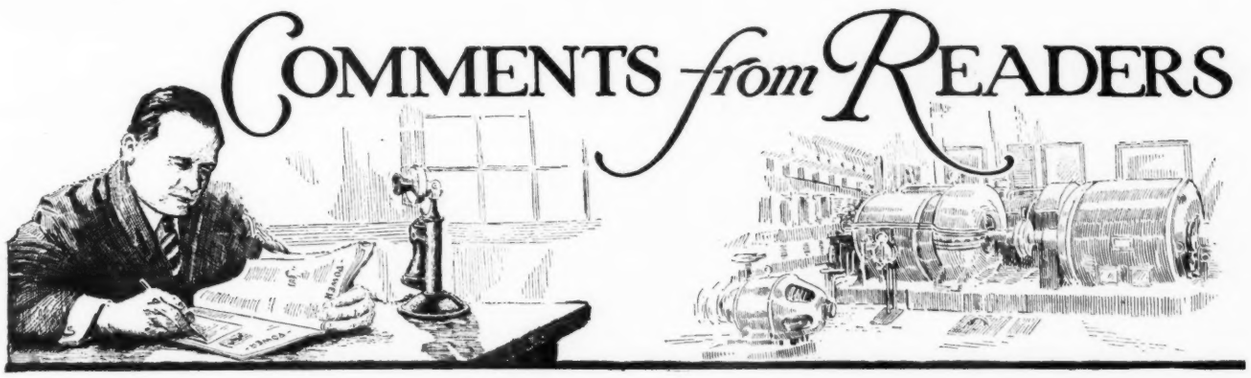
The vacuum on unit No. 5 was but 9 in., and the condenser was half full of condensate. This was due to the vent having been taken off the condensate pump. The air pump was discharging water, which was being drawn over from the condenser.

The temperature rise of the circulating water was about 25 instead of 10 deg., showing that the circulating pump was delivering only about one-third capacity. Upon further investigation the suction on the pump was found to be 21 in. of mercury, although the lift was only about 7 ft. This was probably caused by the resistance in the suction pipe, which was made up of a gate valve, check valve, strainer, several elbows and 100 ft. of pipe, all of which were the same size as the pump suction.

During the noon hour we reconnected the vent of the condensate pump, and when the turbine was put back into service and the condenser drained of the condensate, the vacuum went up to 21½ in. when operating under full load. On Saturday and Sunday we replaced the old 6-in. suction with a new 8-in. line without any valves, strainers, etc. Monday morning, when the turbine was placed in service, we were able to get a 27-in. vacuum with the same circulating-water temperature and full load on the turbine. We again took the inlet and outlet circulating-water temperatures, and the heat balance showed that we were getting about full capacity on the circulating-water pump.

We then turned our attention to the air leaks, and after tightening all joints and painting with asphalt paint, we could bring the vacuum up to 28 in., which was the guaranteed vacuum at full load, with 70-deg. circulating water. The circulating-water temperature did not vary more than from 68 to 72 deg.

Phillipsburg, N. J. JOHN KIRGAN.



Cutting Oil Grooves in Bearings

Referring to the correspondence on page 943 of the Dec. 13, 1921, issue of *Power*, "Using a File on Bearings," by Charles J. Mason, my experience with heavy rolling-mill engines, blast-furnace engines, heavy gas engines using producer, blast-furnace and natural gas, both four-stroke-cycle and two-stroke-cycle, leads me to differ from Mr. Mason, in a friendly way, as to the value and need of oil grooves in bearings. He says oil grooves should be considered only when conditions are abnormal, but that for every-day practice there is no need of grooves.

I agree that the factors that influence the lubrication of bearings are as he states. I disagree on the question of oil grooves. The following will illustrate why: We had a 42 x 84 x 60-in. vertical blowing engine with the air cylinder above the steam cylinder. The crosshead was connected by two side rods to crankpins on the outside of the flywheels. Difficulty was encountered in operating this engine because the main bearings got hot, although they were getting plenty of good, clean oil.

The bearings were run about 0.006 in. loose, the top caps were well grooved for the distribution of the lubricants, and there was ample means for oil to find its way to the bottom half of the bearing, which had no oil grooves in it. This lower half of the shell could be taken out by jacking up the shaft a few hundredths of an inch. I examined these bearings and found them in excellent condition, but with all my care and attention, and although feeding plenty of oil, the temperature remained around 170 to 180 deg. This was too near the danger zone to suit me. We depended more on this engine than on two smaller ones, and to shut down a blowing engine is out of the question.

The crankpin bearings also ran warmer than they should, although they were in good shape, only needing a slight scraping of a few high spots and chamfering of the oil grooves that had worn rather sharp. The bottom halves had no oil grooves.

An old Scotch engineer, who taught me much of what I know of engineering, was an advocate of deep oil grooves in both the upper and the lower halves of bearings. I tried oil grooves on the crankpins of this blowing engine and cut them wide and deep, gave the brasses 0.004 in. clearance and started up. A little heat developed, probably because of a changed bearing surface, but after a six hours' run the bearings cooled off to about blood heat, and then were seldom much above the room temperature.

At the first opportunity we dismantled the main bearings, cut oil grooves in the brasses and scraped them rounded at the edges, gave them proper clearance by leading them to 0.006 in. and left the holding-down nuts one-half turn loose, so that we could loosen up quickly in case of trouble, and started up. By the time the second watch came on, the bearings were running at about blood heat. The bearings of the other two blowing engines, also those on the electric-light engine, were treated in the same way, and gave no further trouble.

Leaving this position to act as an erecting engineer for a gas-engine building firm, I encountered a "puzzler" in a horizontal twin-tandem four-cylinder natural-gas engine, directly connected to a 180-kw. alternator. The engine shaft was but 6 in. in diameter and was supported by four bearings, the shaft diameter in each being 5¼ in., and there was 44 in. between the two inner bearings. After the engine was erected, there was trouble from the start with all four bearings, although they were well lined up, having been set with a transit and level. The engine was shut down, the shaft raised and all bearing surfaces were examined. It was then found that there were no oil grooves in the bottoms of the bearings, which were chain-oiled throughout and the bearing surfaces were lightly polished. The shaft was dropped back into position and a test run made. The operator was coached on operating the engine and cautioned to be sure that the oiling chains were operating constantly, otherwise there would be trouble. The bearing temperature was always around 140 to 150 deg. F. and the room temperature was around 90 degrees.

The company often complained, as time went on, about the high temperature at which these bearings ran. I had just finished another installing job when I was told to go and see what could be done to remedy the trouble. The shaft was lifted out, and we finished with the bearings by Sunday noon, and then ran for three hours. The bearings ran slightly warm for two hours, but cooled off considerably before the engine was shut down. On starting Monday morning, the engine ran cool, as was expected—all the result of cutting oil grooves in the lower half of the shell. I did the same thing with the same satisfactory result on the same type of engine, only larger, at another plant.

Carrying out the practice of making grooves on a 2,000-hp. two-stroke-cycle gas engine did not prove successful, as matters were not helped much. In this instance the babbitt linings were found cracked and in such bad shape that they could be moved slightly by a pressure of the thumb and oil would ooze from many fine cracks. These moveable linings were anchored by drilling holes and filling them with melted babbitt, and after they had been scraped carefully, giving proper clearance and wearing down, a slight improvement was noted.

In another instance a large horizontal blowing engine suddenly gave trouble at the main bearing. The bearings were 18 x 28 in., and all oilways were found full of babbitt, some of it being deposited in the lower shell. This was cleaned out and the oilways were recut and the unit started again. The same thing occurred again in two weeks. Oilways were recut in the upper shells, and at the same time deep cuts were made in the lower shell. Previous to this the bearings had given some trouble by heating slightly, although they always had ample lubrication, as a couple of streams of oil the size of a lead pencil flowed to each. There was no more trouble from heating after cutting the oilways.

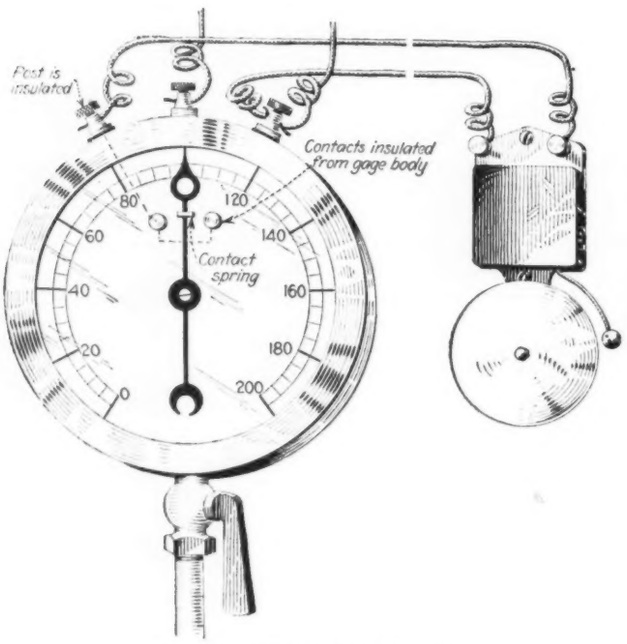
Many other instances could be cited to prove my contentions, but if there is doubt as to the merits of oil grooves, try the bearings without oil grooves in the lower half of the bearing. If heat develops and all conditions are as they should be, then cure the trouble by the judicious use of oil grooves. If oil grooves are made, cut them right. Do not cut away too much of the surface, and lead the oil to the center of bearings. Keep the grooves away from the ends of the bearings or the oil will run out. D. L. FAGNAN.

New York City.

Waste of Steam at Safety Valves

On page 988 of the Dec. 20, 1921, issue of *Power*, is an inquiry from C. A. B. about his trouble with the popping of safety valves and the losses from the same.

Here is the way that I overcame a similar trouble in my plant years ago. A high- and low-contact gage was



WIRING OF GAGE AND GONG

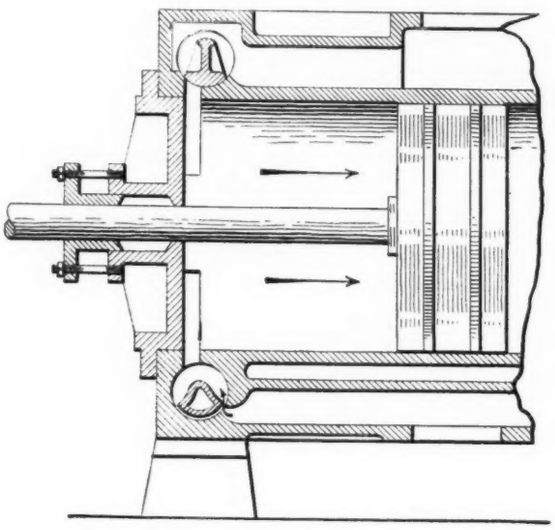
procured and set to ring a 4-in. gong at the desired pressures, or with us at a low pressure of 90 lb. and a high pressure of 107 lb.; the safety valve pops at 110 pounds.

Before the valve pops, the gong begins to ring, thus giving the fireman warning. He at once takes measures to prevent the popping losses. It certainly has saved us money. The sketch shows the idea. A battery or a low-tension current can be used for ringing the bell.

Binghamton, N. Y. P. HYDE.

Wrecking a Compound Engine

On page 73 of the Jan. 10 issue J. Cassiday explains how it is impossible for a compound condensing engine to be wrecked and adds this significant remark: "This never happens if the pump is working correctly." As we agree upon this point, there is no argument to



ILLUSTRATING HOW WATER MAY BE DRAWN INTO A CYLINDER

present. He avoids stating what can easily happen if the pump does not work correctly.

I have watched the end of the exhaust pipe of an automatic non-condensing engine carrying a very light load, resulting in a short cutoff and a low terminal pressure. A puff of steam would come out, quickly followed by a reverse action that would draw in air. If a supply of water had been in the exhaust pipe near the cylinder, it certainly would have been drawn into the cylinder. The low-pressure piston of a cross-compound engine may be drawn forward by the action of the high-pressure side, with no steam in the cylinder, hence there is sometimes the possibility of the piston producing a pumping action and drawing condensing water into the cylinder.

Although Mr. Cassiday disputes my claim, he makes this statement: "This would, of course, flood the condenser and engine, and seaweed entering at *B* would naturally be carried into the cylinder." Where is the argument?

I will go further here than I did in my former article and state that water can be drawn into the cylinder when the exhaust valve is closed, as we ordinarily use the term. In the illustration the exhaust valve is apparently closed, but if conditions under which the engine is run produce a low terminal pressure, this valve will chatter and rattle, which, of course, means that it opens and closes several times during each stroke of the engine.

Mr. Cassiday says that if there is four pounds pressure in the cylinder and five in the condenser, "As soon as the exhaust valve is opened these two pressures are equalized by a flow of air from the condenser to the cylinder."

Ignoring his failure to say how this air is secured, his statement might be true if the piston were at rest, but as it is moving forward, it must draw in a large

volume of steam and water, under certain conditions. When the motion of the piston is reversed, the exhaust valve remains open during about three-quarters of the return stroke. It is then closed, water is trapped, and the result is a wreck. W. H. WAKEMAN.

New Haven, Conn.

With the Heater Flooded, What Would Happen When Starting Up?

On page 31 of the Jan. 3 issue of *Power* J. P. Bruggraf asks what would happen when starting up an engine with the heater flooded. I do not believe that he saved a cylinder head by shutting down. It looks to me as if there was danger of removing one by what he did. In shutting down without an accident, one could make the claim that he had saved his engine from a wreck.

He was starting up his engine and, of course, was taking steam at full stroke. This steam would prevent the water from coming into the engine cylinder, as it would build up a back pressure and force the water in the heater out of the exhaust pipe. When he shut off steam, there was danger of the water going into the cylinder, inasmuch as there would be no steam to keep it out.

Two cases of similar nature have come to my attention, one of them in my own plant. One day the water began to leave the boiler gage glass, dropping from two gages to one inch in the glass. An investigation showed that water was coming out of the exhaust. All the water from a two-inch city main was going into the heater through a broken coil and was being forced out by the exhaust steam. The engine was left running until the water was shut off and heater was clear of water.

The other incident occurred with a friend of mine. The drip pipe on the heater froze and the heater was nearly full of water, or at least he thought so by the sound. On discovering the frozen pipe, he concluded that there was water in the heater, but instead of shutting down he broke off the frozen pipe, which released the water.

If there is steam going through the engine, let the engine run until the water can be shut off and free the heater of water. The steam will build up pressure to force the water out. This refers to simple engines.

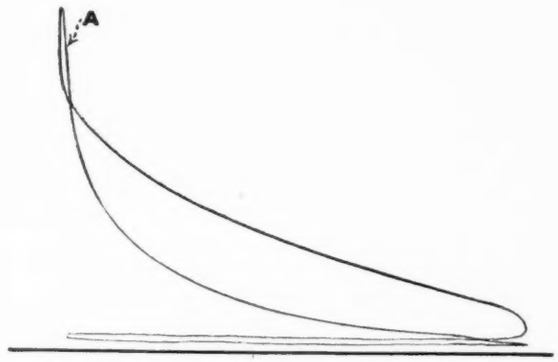
Springfield, Mass. F. C. EARLE.

Why the Loop in the Diesel Indicator Diagram?

In reply to P. K. Jones' inquiry in *Power*, Jan. 10, as to the cause of the loop in the expansion line of a Diesel indicator diagram, herewith reproduced, I would say that some of the characteristics of the working cycle of the Diesel or rational heat-motor engines, may be enumerated as follows:

Production of the highest temperature of the cycle takes place not by and during combustion, but before and independently of it solely by compression of the air charge. Gradual introduction of the pulverized combustible into the heated air during part of the stroke of the piston takes place in such a way that combustion produces no increase in temperature of the gases. After ignition the progress of combustion is not left to itself, but is regulated by external mechanism establishing the right proportions between pressures, volumes and gases.

I scarcely need say that in practice these conditions can be hardly realized, even in good working engines, for the corners of the indicator diagrams are more or less rounded, the course of combustion not being perfectly isothermal. Mr. Jones' diagram is apparently that of a four-stroke-cycle engine. In this case the allowable compression pressure was regulated by the ignition temperature of the fuel. For satisfactory action of an oil engine the introduction of the fuel must occur at a definite predetermined time. In timing the injection it must be recognized that the explosion is not instantaneous, but requires a considerable period of time to arrive at the maximum pressure. The actual duration of the combustion depends on the amount of fuel introduced. The fuel injection should have lead; that is, it should begin before the end of the compression stroke so that the maximum pressure is reached when the crank has just passed the top dead center. The amount of lead varies with the speed and other characteristics of the engine. In the diagram shown, the injection is too early, and the maximum pressure has been



LOOP IN DIESEL INDICATOR DIAGRAM

obtained before the crank has reached its dead center, tending to reverse the engine. Conditions like this usually cause a great shock to the engine, rapid deterioration and lowered efficiency. The immediate external evidence of early fuel injuction is a violent pounding noise in the engine. ALBERT SMITH.

Albany, N. Y.

[Mr. Smith has made a slight error in assuming that the temperature existing in the Diesel cylinder does not rise during the period of combustion. The cylinder pressure ordinarily does not show an increase, but a study of the entropy diagram of a Diesel engine will show that the temperature during combustion rises from 1,200 to 1,300 deg. to a maximum of probably 2,700 to 3,200 deg. F. Isothermal combustion has never been achieved in the working Diesel engine. Undoubtedly, the loop in the diagram must be explained on other grounds than those presented by Mr. Smith. Apparently, the indicator reducing motion was not in phase with the piston.—Editor.]

It is an interesting fact that all the oils coming from petroleum, ranging from heavy lubricating oil to the most volatile gasoline, have heating values coming between the limits of 18,000 and 21,000 B.t.u. per pound. It is therefore evident that 20,000 B.t.u. per lb., the figure frequently used for rough calculations, cannot be far off for any mineral oil.

QUESTIONS AND ANSWERS

Presence of Asphalt in Asphalt-Base Oils

Is the asphalt in an asphalt-base oil dangerous to bearings, and will it plug up oil lines and cause deposits in a circulating system? W. N. M.

Asphalt oils, like all other mineral oils, are produced from the crude by fractional distillation. The asphalt is not driven off and is left in the still. If the oil is properly manufactured, the lubricating oils from asphaltic-base crude cannot contain any asphalt.

Preventing Superheater out of Service from Burning out Without Flooding

How can a superheater that is out of service be protected from becoming burned out without flooding the superheater? A. F. S.

Superheaters usually can be protected from burning out without flooding, by opening a connection from the superheater discharge to the saturated dry steam discharge of the boiler. The circulation of saturated steam thus induced through the superheater is generally sufficient to prevent the superheater from becoming overheated.

Changing from Throttling to Shaft Governor

Indicator diagrams taken from a 10 x 16-in. D slide-valve engine, with throttling governor, show considerable falling off of the pressure during admission. Could not the engine develop more power if fitted with a shaft governor? W. A. C.

The falling away of admission pressure when the engine is loaded, to obtain the lowest running position of the present throttling governor, may be due to contracted steam ports and passages, and there would be the same defect of diagrams made with a shaft governor and balanced valve. The cutoff could not occur so late in the stroke, and although there might be better speed regulation and higher pressure during admission, less power could be developed than from the later cutoff with the throttling governor.

Setting Eccentric for Indirect Valve

How would the eccentric of an engine be set for an indirect piston valve that is coupled to the eccentric rod with a direct rocker? R. G.

A piston valve is like a flat slide valve would be if rolled up in the form of a cylinder with a bored cylindrical seat in place of a flat seat. When, as with the ordinary D slide valve, steam is admitted at the ends of the valve, the steam port is uncovered at the beginning of the stroke of the piston by moving the valve in the same direction as the piston, and with a direct rocker the eccentric must be set 90 deg. plus the angle of advance ahead of the crank. But when the opening edge of the valve uncovers the steam admission port by movement of the valve in a direction opposite to the direction of movement of the piston as would be necessary for admission of steam in the middle of the valve and discharging the steam at the ends, the valve would be called indirect, and to effect the indirect motion with a direct rocker, the eccentric would have to be set 90 deg. behind the crank, less the necessary number of degrees angular advance ahead of that position required by the lap and lead of the valve.

Objections to Placing Tightener on Tight Side of Belt

We are driving a 120-kw. generator with 22-in. receiving pulley, belted from a 10-ft. diameter engine wheel with 20 ft. 9 in. between centers. A tightener idler will be required to prevent slippage of the belt on the generator pulley. The lower side of the belt is the tight side, and there is not room for placing a tightener on the slack side. What disadvantage, if any, is there to placing the idler on the tight side in place of the slack side of the belt for increasing the arc of belt contact on the receiving pulley? P. J.

For obtaining the same contact and driving with the same initial belt tension, and same size and relative position of tightener pulley, the disadvantages of using the idler on the tight side instead of the slack side of the belt are greater amount of friction and wear of the idler-shaft bearings, with requirement of more frequent lubrication to prevent cutting; more pounding of the bearings; and greater severity of wear of the belt from bending it backward with the greater tension of the driving side. When the tightener is on the slack side, the pressure on the bearings is the resultant of upward action of the slack side tension, less the pressure due to the weight of the tightener shaft and pulley. From placing the tightener on the tight side the pressure on the bearings would be the resultant of downward pressure due to initial belt tension, plus the driving pull, together with the pressure due to the weight of the tightener shaft and pulley; and the wear and loss of power from journal friction with the tightener so placed usually amounts to more than three times as much as from placing the tightener on the slack side of the belt, depending on the arrangement, weight of parts, the driving pull and initial belt tension.

Planning Arrangement of Equipment

What is the best method of planning the arrangement for machine tools and equipment of a power-plant machine shop? F. J. B.

For planning the arrangement of machine tools and other equipment make a plan of the room, showing loca-

tions of doors, windows, posts, etc., drawn to a scale of not less than one-half inch per foot, and to the same scale draw and cut out of cardboard, models of floor spaces occupied by each machine or other equipment, showing the location of pulleys or motors, with a distinctive mark like a + sign on the side that is to be toward the operator. The models then can be tacked on the room plan in their approximate positions and may be readily rearranged to obtain a satisfactory layout without going through the tedious operation of redrawing changes of locations.

Pressure and Temperature Attained by Adiabatic Compression of Air

What are the formulas for determining the pressure and temperature attained by adiabatic compression of a given volume of air at stated temperature, when compressed to a stated volume; as, for instance, the pressure and temperature attained by 100 cu.ft. of air at atmospheric pressure and temperature of 80 deg. F. when compressed to the volume of one cubic foot?

W. N. N.

The formula for adiabatic compression is

$$P_2 = P_1 \left(\frac{V_1}{V_2}\right)^n \qquad (1)$$

In the example

$P_1 = 14.7$ = pressure of atmosphere lb. per sq.in. absolute;

$V_1 = 100$ = initial volume in cubic feet;

$V_2 = 1$ = final volume in cubic feet;

$n = 1.406$, a constant.

By substituting, formula (1) becomes

$$P_2 = 14.7 \left(\frac{100}{1}\right)^{1.406}$$

in which the log of $\frac{100}{1} = 2$, and $2 \times 1.406 = 2.812$, which is the logarithm of 648.66

Hence the final pressure would be

$P_2 = 14.7 \times 648.66 = 9{,}535.3$ lb. per sq.in. absolute, or $9{,}535.3 - 14.7 = 9{,}520.6$ lb. gage.

The formula for temperature is

$$T_2 = T_1 \left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}}, \qquad (2)$$

in which

T_2 = Final absolute temperation;

T_1 = Initial absolute temperature, and in the example $= 80 + 459.4 = 539.4$ deg. absolute; $\frac{n-1}{n} = 0.289$.

By substituting, formula (2) becomes

$$T_2 = 539.4 \left(\frac{9{,}535.3}{14.7}\right)^{0.289}$$

$\frac{9{,}535.3}{14.7} = 648.6$; log. 648.6 = 2.812; $2.812 \times 0.289 = 0.8126$ = log. of 6.497. Hence $T_2 = 539.4 \times 6.497 = 3{,}504.5$ deg. absolute, or $3{,}504.5 - 459.4 = 3{,}045$ deg. F.

Preventing Sparking on Compound Generator

We have a 140-volt 1,075-ampere 8-pole compound non-interpole 475-r.p.m. direct-current generator that has been installed since February, 1901. For the last year it has been giving us trouble by sparking, and all attempts to overcome this have been in vain. The mica in the commutator has been undercut, different grades and thicknesses of brushes tried, the brush setting has been carefully checked up, and in fact everything the writer can think of has been tried, but still the trouble remains. The sparking increases with the load, which would indicate that the brushes should be advanced, but there seems to be no position in which commutation is as it should be. Any information or suggestion would be appreciated. G. E. G.

The trouble may be due to improper grades of brushes being used on the generator. After you have tried the other remedies suggested in the following and find that they do not correct the troubles, it would be advisable to put the problem up to some of the brush manufacturers and see what they can do.

First, make sure that the generator is not overloaded. It may be that the ammeter is reading low and the machine is carrying more load than indicated. Check the polarity of each of the series-field coils individually and see if they are alternate North and South poles. Two or three cases come to mind where the series coils were found with wrong polarity. In a machine of this size you should be able to check the correctness of the windings by the direction of the windings on the pole-pieces. Of course you can connect a water rheostat in series with the series windings and send about 100 amperes through these coils and make the check with a compass, also check the polarity of the shunt-field coils. After you have checked the polarity of the field coils, test the shunt coils for short-circuits. This can be done by connecting the coils across the line and then connecting a voltmeter to the terminals of each field coil. If all of the coils are in good condition, the meter should read $\frac{1}{8}$ of 140, or 17.5 volts when connected to the terminals of any one cell. A low reading will indicate a short-circuit in this particular coil.

Non-Releasing Corliss Engine

What is meant by a non-releasing Corliss engine, and what are its advantages? B. W. E.

The non-releasing Corliss engine is a combination of the automatic high-speed and double-eccentric Corliss engine. Each end of the cylinder is provided with an admission valve of the Corliss type. These valves are connected directly to a reach rod which is operated by an eccentric rod of an eccentric that is moved around the shaft by a shaft governor, and by means of which the speed of the engine is regulated by variation of the point of cutoff.

As connections of the admission valves with the eccentric are positive, engines equipped with this type of valve gear may be used directly connected to electrical generators and other purposes for which the high rotative speeds of shaft-governor engines are adapted, whereas the speeds permissible with disengaging mechanism is limited to the time required for its proper operation. The exhaust valves are the Corliss type of valves operated by a separate eccentric which is fastened to the shaft. Hence the steam distribution is better than that obtained with single-valve automatic high-speed engines, because release and compression can be fixed at the most advantageous points, and they remain unchanged with variation of the cutoff. Other advantages over single-valve engines are large opening, quick closing and small clearance obtainable with Corliss valves. There also is the advantage of employing separate valves for admission and exhaust. The exhaust steam has a lower temperature than the admission steam, and when a single valve is used, part of the admission steam is condensed from coming in contact with the valve thus cooled by the exhaust.

Motors for Elevator Service*

BY HARRISON P. REED
Electrical Engineer, Cutler-Hammer Manufacturing Company

MOST of the modern direct-current motors, for elevator service, whether shunt or compound wound, have suitable commutating pole windings so as to insure sparkless commutation in both directions of rotation. The commutation should be such that with heavy momentary overloads at starting and during dynamic braking, the commutator will remain in satisfactory operating condition without need for frequent attention.

Direct-current motors are of two general types, single-speed and adjustable-speed, the latter having speed control by shunt-field variation. For low-speed, heavy-duty service the motor is usually compound wound to produce sufficient starting torque. The compound winding should represent from 10 to 25 per cent of the total ampere turns on the main poles of the motor, disregarding the commutating pole windings. The compound winding should be cut out of circuit after starting, so as to insure more constant speed characteristics. To reduce the speed to insure accurate stopping, it is necessary to insert resistors both in series and in parallel with the armature. This means inefficient starting and stopping and increases the power consumption materially, as the number of stops per car mile increases. The parallel resistor is also used to secure dynamic braking in the off position.

Adjustable-Speed Motors

The adjustable-speed, shunt-wound motor, usually having a speed range of two-to-one or more by shunt-field control, provides ample starting torque without a compound winding. For high-speed installations, if this type of motor is used, the elevator can be run at full-field speed practically as efficiently as at high speed. In transferring from high to full-field speed the motor acts as a generator and returns current to the line. The amount of this returned current has been found from actual test of a three-to-one motor to equal 10 per cent of the total power consumption on an elevator making 150 stops per car mile. For slowing down from full-field to "drag" speed, series-parallel resistor connections are used, but the horsepower is only a fraction of that at high speed, so that a saving of power at drag speed is realized over power used in slowing down a single-speed motor. Should anything happen to the armature-shunt contactor or to the armature-shunt resistor circuit the operator can always slow down to full-field speed and make a safe stop without dynamic braking. One thing against the two-speed motor is that for the same horsepower and speed it must be somewhat larger and more expensive than a single-speed motor. It is highly important that the two-speed motor be designed to provide stable speed conditions when running with a weakened field.

Alternating-Current Motors

Alternating-current motors for elevator service are of two general types; the high-torque squirrel-cage induction motor and the slip-ring, wound-rotor induction motor. The squirrel-cage motor is used extensively up to about 20 hp. because of its simplicity and because it only requires a relatively simple form of controller as it is generally thrown across the line with no starting resistor. When the installation is such as to require a smooth start, a resistor or reactance is placed in the motor primary circuit and gradually cut out after starting.

The last method of starting has been applied to motors as large as 50 hp. with success. However, it has one disadvantage in that its speed regulation is poorer than that of a wound-rotor motor. While this is of little moment for the lower-speed elevators, it may not be satisfactory on the higher-speed cars. It is of interest to note that this regulation is not as bad as that of a hydraulic or a steam elevator. In actual service the power consumption of the squirrel-cage motor is slightly higher than that of the slip-ring machine, but due to the lack of slip-rings and fewer controller parts it is somewhat more reliable. The slip-ring motor for the same rating is more expensive and has a somewhat lower power factor than the squirrel-cage motor.

Single-speed alternating-current motors cannot ordinarily be applied to elevators running faster than 200 ft. per min. because no slow-down can be obtained under the varying load conditions met with in elevator service, and no dynamic braking is available to assist the mechanical brake in bringing the elevator to rest. This means therefore, that the mechanical brake must be depended upon to stop the car satisfactorily from the full running speed. This is a difficult problem. The energy stored in the moving mass is proportional to the square of the velocity. The mechanical brake is capable of absorbing this energy only in direct proportion to the velocity, while a dynamic brake will dissipate this energy in proportion to the square of the velocity. The dynamic brake, unavailable with alternating current, is an important adjunct in assisting the mechanical brake for quick, smooth stopping of the elevator. While the development of the two-speed alternating-current elevator motor is still in its infancy the demand is so great that rapid perfection of this type of motor for passenger-elevator needs is to be reasonably expected. Alternating-current motors are very reliable, and alternating current is daily coming into wider commercial use, so it is quite essential that drastic efforts be exerted along these lines.

The available two-speed alternating-current motors today generally have two primary windings, although some motors are manufactured with but one primary winding which is re-connected to give a range in speed control.

In the two-winding type of motor the connections are usually so arranged that the speed of the motor can be changed without disconnecting the motor from the supply circuit, so that the motor is at all times operating under a positive torque and there is therefore no danger of losing control of the load.

Tendency Toward Squirrel-Cage Motor

Two-speed alternating-current motors are built in both the squirrel-cage and wound-rotor types. The wound-rotor, two-speed motors have two secondary windings. Most of them have five slip rings so as to get the advantage of independent accelerating adjustments for the two windings. There seems to be a tendency toward the straight two-primary winding, squirrel-cage motor which is simpler and which has been found to give even smoother and quieter operation than the other type. Most two-speed motors have three-to-one speed range. Advantage is taken of the fact that in changing connections from the high- to the low-speed windings, with the car running at full speed, the low-speed winding acts as an induction generator, giving a very powerful slow-down action. This change is somewhat difficult to control smoothly under varying-load.

Some manufacturers, in order to get positive speed control with alternating current are using two motors of different rated speeds, both of which are direct-connected to the elevator machine. This scheme permits the use of a squirrel-cage motor for the low-speed member and a slip-ring motor for the high-speed member. With this arrangement it is possible to obtain the advantages of lower-slip and higher-operating efficiency which are characteristic of the slip-ring motor. Another point in favor of the two-motor arrangement is that the windings are in the usual form with which all repairman are familiar and therefore the chances are that quicker repairs can be made. Also equipments have been built consisting of two distinct motors, both in one motor frame.

The two-speed alternating-current motor is being successfully used with car speeds as high as 350 ft. per min. Further development will undoubtedly increase this value.

*Abstract of a paper published in the Journal of the American Institute of Electrical Engineers. This paper was prepared under the auspices of the Subcommittee on Elevators of the Industrial and Domestic Power Committee.

Water Power League Speaker Praises St. Lawrence Plan

At a "Power Conference" held in New York City Feb. 7-8 by the Water Power League of America, Henry I. Harriman, president of the New England Power Co., enthusiastically championed the plan now before Congress for developing the power and navigation possibilities of the St. Lawrence River. There was some contrary discussion on the same matter, and an unsuccessful effort was made to put through resolutions opposing Mr. Ford's Muscle Shoals offer, proposing the repeal of the Federal Power Act, and calling upon Congress to help in financing water-power development.

Address on St. Lawrence Canalization

On the first day, Feb. 7, the St. Lawrence Canalization project was the subject of a careful and wholly favorable address by Henry I. Harriman, president of the New England Power Co. Mr. Harriman declared that the project ought to be put through because it would have a good effect upon the country as a whole, upon New England, and even upon the State of New York. He pointed out that the channels of trade run east and west, whereas practically all of our navigable rivers run north and south, with the exception of the St. Lawrence, and that in this river there are but two obstacles between the Great Lakes and the ocean; namely, Niagara Falls and the St. Lawrence Rapids. Within three or four years the Welland Canal will allow 15,000-ton ships to pass around the Falls and down the river as far as Ogdensburgh, where they would be held up by the first rapids. He explained that the report now before Congress, providing for opening the remaining portion of the river to navigation, calls for one power dam and two canals.

Mr. Harriman said that the carrying out of the plan would have three effects upon New England and New York: It would give them a great deal of cheap power, it would provide a cheap water route, and it would, he admitted, probably divert some foreign commerce from these districts.

He went into considerable detail on the first of these points, relating to the cost of power. He gave the complete cost of the finished project as $250,000,000 and figured that the interest charges and sinking-fund allowance on this would not exceed 5 per cent per year, or $12,500,000. To this he added the estimated operating cost of $2,500,000, making a total yearly cost of $15,000,000 for an estimated output of 1,500,000 hp. This, of course, would indicate the very low rate of $10 a horsepower, which he believed would make possible the selling of electric power 300 miles away from the plant on a 50-per cent load factor at from 6 to 7 mills per kilowatt-hour. Development of this power from the river, he said, would result in a saving of 36,000,000 tons of coal a year.

The speaker also went into detail regarding the lower freight rate that the canal would give the New England and New York districts. He estimated that it would be possible to ship goods from Boston to Chicago, for instance, over the St. Lawrence at one-third the present rail cost, and that this condition would have the natural effect of bringing down railroad rates, which would be another benefit to the East.

As for the question of the diversion of foreign commerce from the ports of New York and New England, it was his opinion that the effect upon the country as a whole should be considered above local considerations such as these.

He closed with a quotation from a recent speech of President Harding to the Agricultural Conference, in which the President warmly praised the St. Lawrence project and declared it to be of the greatest importance to the country.

Discussion

In the discussion that followed, E. H. Sargent, of the New York State Water Power Commission, stated the position of New York to be that the project is impractical as far as navigation is concerned, but that it is practical as a power development. He said that under the present plan of development the power derived from the river is going to be made to bear the burden of developing the navigation facilities, and insisted that the navigation part of the project should stand or fall on its own merits. He stated also that the proceeds of the sale of the power generated should come to New York State rather than to the Federal Government, and that the state had already issued three preliminary permits to private corporations who would pay a revenue to the state for development of this power.

In answer to these statements Mr. Harriman pointed out that he had not gone into the details of financing the project or of distributing its proceeds, and that these could be arranged later so as to provide for a division of the revenue between Canada and the State of New York.

The Ford Currency Plan

On the second day, Feb. 8, Charles Edward Russell spoke at length on the so-called Ford Currency Plan, and three resolutions were proposed, all of them, however, being tabled. One of them aimed to put the League on record as favoring the rejection of Henry Ford's and every other offer for the Muscle Shoals project on the ground that the development should be made by the Government itself and should not be put into the hands of any individual or private corporation. Another resolution stated that lack of money is holding back development of 50,000,000 hp. of hydraulic eenrgy, and that Congress should relieve the situation by legislating for the issuance of Federal Reserve notes against the bonds of companies projecting such developments. A third resolution provided for the repeal of the Federal Power Act, for transferring control of the Federal Power Commission (established under that law) to the engineering branch of the Army, for establishing "superpower zones" throughout the country and for assisting in the financing of power projects.

Although it was impossible to secure enough votes to pass these resolutions, the members present did come to an agreement on seven of the eleven amendments to the Federal Power Act proposed by the Boston Society of Engineers. Among the amendments approved was one proposing that the accounting requirements be only such as are required by the Public Service Commission of the state in which projects are located, and one proposing that the present form of commission of cabinet officers be abolished and the work placed in a suitable department for administration.

Secretary Weeks Testifies on Ford Offer

Testifying before the House Committee on Military Affairs on Feb. 8, Secretary Weeks said that he considered Ford's Muscle Shoals offer imperfect, in that it made no absolute guarantees that the terms of contract would be carried out, and suggested a bond to guarantee this. He is opposed to a 100-year lease and believes that it should be 50 years. If he could be convinced that the proposition would result in cheaper fertilizer, he would favor the offer, but he does not believe that Ford can make good on the fertilizer claim. If this phase of the matter were removed, he believes other disposition of the project could be made of greater benefit to the government.

Questioned as to the latter statement, he said that it proposed holding Nitrate Plant No. 2 as at present, the leased steam plant meeting the maintenance charges on the nitrate plant. He would then ask Congress for authority to complete the Wilson Dam and issue bonds to cover the cost. The dam and hydro-electric plant would then be leased to a private power company on some basis that would cover the fixed charges.

This would obviate the necessity of building dam No. 3, which is stipulated in the Ford offer, but which would not be warranted by immediate demands for power.

Five proposals had been received for the Muscle Shoals project, he said, but two had been withdrawn, one because the parties submitting it were unwilling to have the decision of its acceptance made by Congress; the remaining two proposals, namely the Engstrum and the Tinker, would be passed to Congress within a few days. He admitted, however, that the Ford offer was the best received to date.

Regarding the options held by the Alabama Power Co. and the American Cyanamid Co., the Secretary said that the Judge Advocate General's office had advised that these

would not hold if the Ford offer were accepted, although he personally believed that they might involve serious litigation. In any event Ford would have to assume the agreement to pay royalty to the American Cyanamid Company. The land upon which the transmission lines are constructed belongs to the Alabama Power Co., and under the Ford proposal this would have to be acquired by the Government, also the water rights in connection with Dam No. 3. This would involve an expenditure of from $1,500,000 to $2,000,000 by the Government.

Judging from the remarks of the members of the committee interrogating Mr. Weeks, they appear to be about equally divided on the Ford proposal, with a disposition to obtain more favorable terms from Mr. Ford if possible. Whatever action is finally taken will undoubtedly bring on the probability of obtaining cheap nitrates for fertilizer.

Explosion in Furnace of Oil-Burning Boiler

That those engaged in operating fuel-oil burning boilers are not immune from accident was again made evident when eight men were painfully burned on the Canadian Pacific liner "Empress of Scotland" at Pier 59, New York City, early in the morning of Feb. 2.

The boiler in which the flareback occurred was one of ten, and was used as an auxiliary unit, and the only one that operated on natural draft. All the boilers had recently been changed from coal to oil burners. Trouble had been had in properly regulating the oil and air supply on the auxiliary boiler, which was of the Scotch marine type, having three furnaces each equipped with a pressure-type burner using oil under a pressure of 100 pounds.

At the time of the accident the engineers were engaged in an attempt to obtain a proper mixture of oil and air. When one of the engineers opened a door on one of the furnaces to observe conditions, an explosion or flareback followed.

Charcoal Gasoline Recovery Patent Granted

A patent covering an apparatus for the recovery of gasoline vapors from casinghead gas, has been granted to the Gasoline Recovery Corporation.

The apparatus consists of drums filled with activated charcoal and connected on one side to a steam boiler and on the other to gasoline condensers. In operation the gasoline-heading gas is allowed to flow through one of the drums of charcoal which, being extremely porous, absorbs and retains the gasoline, allowing the rest of the gas to pass through unchanged. Steam at low pressure is later used to drive the gasoline from the charcoal.

Trials made during the last few months with steam-turbine locomotives on some sections of the Swiss Federal Railways are reported as a complete success. These locomotives are of the Zoelly type and are built by the Swiss Locomotive Works, of Winterthur. The value of the engines is well illustrated by the fact that the Krupp Works of Essen have acquired the German as well as all other foreign patents, and will soon start the manufacture of these locomotives. In their appearance the steam-turbine locomotives differ very little from the piston type. Two small turbines are mounted below the boiler, one for the forward and the other for the backward motion. The transmission of the propelling power to the axle wheel is effected by means of gearing and a crank driving gear.

The Federated American Engineering Societies has appointed a new committee on registration of engineers, comprising A. S. Dwight (chairman), New York; Gardiner S. Williams, Ann Arbor; and Philip N. Moore, St. Louis. A new Federal water-power committee also has been named, consisting of John H. Finney, of Washington, (chairman); Calvert Townley, New York; G. S. Williams, Ann Arbor; Gano Dunn, New York; and A. P. Davis, Washington.

Recent Court Decisions

By A. L. H. Street

Liability to Power Consumer's Employees

Where a company contracted merely to furnish electrical energy for power to the operator of a linter washing and drying factory, it was not liable for death of an employee in such factory, who, when lights went out on account of a failure of power, fell into vats of boiling chemicals, there being no duty on the company toward the employees as agent of the employer or otherwise. This is the gist of the decision reached by the Mississippi Supreme Court in the case of Mullican vs. Meridian Light and Railway Co., 83 "Southern Reporter," 816. The court said:

It is clear to us that the contract obligated the light company to do no more than to "furnish to the party of the second part electrical energy for power purposes at the premises occupied by the party of the second part, known as a linter washing and drying factory."

The contract imposed no duty upon the light company to furnish lights and keep them burning in the factory for the use and safety of the employees therein. No such service was promised or contemplated under the contract, therefore it necessarily follows that, since there was no such duty on the part of the light company toward the deceased, there can be no liability against it for damages on account of the unfortunate death alleged to have been caused by the extinguishment of the lights in the plant.

Engines and Machinery Judicially Defined in an Employers' Liability Case

The Louisiana Supreme Court gives a broad meaning to the word "engine" in the case of Haddad vs. Commercial Motor Truck Co., 84 "Southern Reporter," 197. Holding that an employee killed through falling from a motor truck he was driving, and being run over by the wheels, was killed while engaged in operating an "engine" or "other form of machinery," within the meaning of the Louisiana Employers' Liability Law, the court said:

"The word engine is defined as an ingenious or skillful contrivance used to effect a purpose, and is often synonymous with the word machine. Within such definition, an electric passenger elevator is an engine. Lefier v. Forsberg, 1 App. D.C. 36, 41." "Words and Phrases," Vol. 3, p. 2395.

An engine, according to the "Century Dictionary," is:

"A skillfully contrived mechanism or machine, the parts of which concur in producing an intended effect; a machine for applying any of the mechanical or physical powers to effect a particular purpose; especially a self-contained, self-moving mechanism for the conversion of energy into useful work; as a hydraulic engine for utilizing the pressure of water; a steam, or gas, or air engine, in which the elastic force of steam, gas, or air is utilized."

According to the same authority, machinery is defined as follows:

"The parts of a machine considered collectively; any combination of mechanical means designed to work together so as to effect a given end, as the machinery of a watch, a canal lock; any complex system of means and appliances; any mechanical device to carry on any particular work, or keep anything in action, or to effect a specific purpose or end; as the machinery of government."

There could be but little doubt that if the deceased had been required, in the course of his employement, to operate a stationary gasoline engine on the premises of the defendant, the service would have fallen clearly within the provisions of the Employers' Liability Law, no matter for what purpose its use might have been intended. Can it be said that, because he was required to operate the same character of engine in a self-propelling vehicle, the statute does not apply? We think not. Would the driver of a motor bus for the transportation of freight and passengers be engaged in the operation of an engine or machinery? We think so. Not only does the operation of a motor truck involve the operation of an engine (gasoline), but also the operation of machinery, in its broader sense, as defined by the authority above cited. It involves the operation of the gasoline engine, as a part of the machinery of the truck, which in the ordinary, common, and everyday use of the word is a "machine."

News in the Field of Power

Hydro-Electric and Fuel Papers for A.S.M.E. Spring Meeting

Since Atlanta, Ga., has been chosen by the American Society of Mechanical Engineers for its spring meeting, May 8-11, it is expected that the program will lay special emphasis on the development of the Southeast. The power division, therefore, will probably arrange for one or more papers on hydro-electric development in that part of the country. It has also secured a paper giving the results of recent tests on the 60,000-kw. turbine at the Interborough Rapid Transit Co., in New York City.

The papers so far planned by the fuel division are to be given by: Dr. E. A. Uehling, of Milwaukee, who will describe the relation of combustible coal elements to the oxygen content, and the establishment of a fuel unit of practically constant heat value for over 90 per cent of all bituminous coals; C. W. E. Clarke, of New York City, who will tell about boiler-room performance and practice at the Colfax Station of the Duquesne Light Co. and at the Seward Station of the Pennsylvania Public Service Corporation; and F. G. Cutler, of the Tennessee Coal and Iron Co., who will discuss the reduction of fuel wastes in the steel industry.

Water Power Applications

Applications for preliminary permits during the week ended Feb. 4 have been received by the Federal Power Commission as follows:

The Utah Power and Light Co., of Salt Lake City, has applied for a permit covering the development of power in Green River between Flaming Gorge in northern Utah and Rattlesnake Canyon, above Green River, and the power in the Gampa River between Craig, Colo., and the junction of the Gampa with the Green River. The method of development proposed on the Green River is by a series of six dams and pools with power houses at each dam. The Gampa development is to be made by a series of four dams and power houses. The total primary power that will be made available by these projects is estimated at 560,000 hp. The installation contemplated is 800,000 horsepower.

The Houston Power Company of Newton, Alabama, has submitted a plan for the construction of a dam 33 feet high in the Choctowhatchee River, just above Newton. The power house is to be an integral part of the dam. It is estimated that 600 hp. of primary power will be available, but it is the intention to install equipment to generate 3,000 horsepower.

The Eureka Hydroelectric Company of Eureka, Mont., has applied for a permit covering the construction of a dam, a flume and two powerhouses on Graves Creek, nine miles from Eureka, Montana. Some 750 hp. of primary power is estimated to be available, but the company expects to install equipment sufficient to generate 2,500 hp. The power is to be used for irrigation and public utility purposes.

The Spirit Lake Railway and Power Co., 110 East Twelfth St., Vancouver, Washington, requests a permit to cover projects on Toutle and Green Rivers in Cowlitz County, Washington. The site covered by this application is just below the company's project at the outlet of Spirit Lake. The primary power at that point is figured as being 40,000 hp., and the company announces its intention to install 50,000 hp., to be used for public-utility purposes.

Views on the Coal Strike

The action taken by the operators in the Pittsburgh and southern Ohio districts leads coal specialists in and out of the Government service in Washington to the belief that there now is little chance of avoiding a strike. The Attorney General has made it clear that he regards the situation as being sufficiently serious to justify the formulation of complete plans for the part he expects to play in case the strike is called. On the other hand, disinterested observers are of the opinion that such a strike has little chance for success. With the domestic demand practically out of the way by April 1, the non-union fields are in a position to supply practically all the coal that the country will use. Stocks sufficient for six weeks or more will have been built up by the railroads, public utilities and most of the industrial consumers. There would be no deep-seated regret on the part of many industrial plants if they should be forced to close down for a month or so this spring.

The economic situation is against the miners, and the operators are more than willing for a decisive fight. On the other hand, it is realized that the men have an unusual advantage in the leadership of John L. Lewis.

James Again Heads Western Pennsylvania Engineers

The Engineers' Society of Western Pennsylvania, at its recent annual meeting, elected H. D. James president, Frederick Crabtree vice president, and J. C. Hobbs and C. D. Terry directors. Mr. James is the manager of the control engineering department of the Westinghouse Electric and Manufacturing Co., and has served in the society as director for three years and as president for the last two years. He is a graduate of the University of Pennsylvania and is a member of the American Institute of Electrical Engineers. The society in which he continues as president has a membership of over 1,400 and maintains its permanent headquarters in the William Penn Hotel in Pittsburgh.

Work Resumed on Tugaloo River Plant

The hydro-electric power development of the Georgia Railway and Power Co. on the Tallulah and Tugaloo Rivers will now be completed, as construction work is to be resumed shortly after a lapse of some three years caused by war-time conditions. The development was started about three years ago. At that time the water-wheels and electric equipment were ordered, and most of this equipment is now installed or ready for shipment.

The dam will be 124 ft. high, 130 ft. thick at the base and 850 ft. long at the top. The plant will be equipped with four 22,000-hp. waterwheels driving vertical 6,600-volt generators. There will also be an auxiliary unit of 1,000 hp. for plant use. Power will be transmitted to Atlanta and other points at 110,000 volts.

Welding Society Seeking New Members

The American Welding Society, which was organized in 1919 and which has suffered since that time from many of the usual difficulties of a young organization, is now making a renewed effort to increase its membership and to re-establish and broaden its activities.

The Society's statement of its object declares "The field for further application of welding is enormous, and progress in it is being delayed only by incomplete knowledge, and by the confusing and opposing claims of competing interests." There are a number of local sections in Eastern cities, and more are being organized in the West. These sections hold monthly meetings, at which papers are given, the object being to interest manufacturers, engineers, plant superintendents, foremen, operators and others interested in welding to exchange their views and experiences on welding.

To secure this interest on the part of different classes of men, there have been established five classes of membership, comprising honorary members, sustaining members, associate members and operating members, the annual dues running from $100 down to $6. Thus, almost anyone concerned with welding problems may join the organization.

An important part of the Society's work is the Bureau of Welding, which is a joint advisory board of the Ameri-

can Welding Society and the division of engineering of the National Research Council, on welding, research and standardization, acting as the research department of the society.

Considerable literature is put out by this bureau, and by the society itself. Two recent bulletins put out by the bureau are "Standards for Testing Welds" and "Welding Wire Specifications and Folios." The first describes a simple practical test, a commercial test for quantity work, and an elaborate test for research work. The Society has started off the new year by publishing its Proceedings in pamphlet form, the January number containing news items about its activities and two technical papers entitled "Arc Welding of Cast Iron" and "Safeguarding the Oxyacetylene Process."

The present officers are: S. W. Miller, president; J. W. Owens and C. A. McCune, vice presidents; W. E. Symons, treasurer; and M. M. Kelly, acting secretary. Headquarters are in the Engineering Societies Bldg., at 29 West 39th St., New York City.

New Publications

Mechanical World Year Book for 1922. (25th edition.) Published by Emmott & Co., Ltd., 65 King St., Manchester, England. Paper, 4 x 6 in.; 614 pages. Price, 2s. 6d.

About 350 pages are devoted to a conventional engineer's handbook, in which a large amount of space is given to power-plant apparatus, such as steam engines, turbines, boilers, condensers, Diesel engines, etc. Although space is naturally limited, a number of mathematical tables have been included, covering squares, cubes, roots, logarithms, trigonometrical functions, etc. The remainder of the book consists mainly of advertisements of English products, but includes also a few tables of general interest, and directories for French, Russian and Spanish buyers.

Mastering Power Production. By Walter N. Polakov. Published by the Engineering Magazine Co., New York City. Cloth, 6 x 9 in.; 455 pages, including appendix and index; 138 figures and numerous tables. Price, $5.

This book differs markedly from the average book on power plants. Mr. Polakov has taken an engineering subject and bound it up so intimately with his philosophy of life that separation would be practically impossible. The title might well be the "Philosophy of Power," using the word philosophy in a broad sense to mean the relation of power to man and his problems. For this reason the impression any particular reader will get from reading this volume will depend largely on how he is accustomed to view social and economic problems.

Some idea of the field covered may be gained from the following chapter titles: The descent of the principle of production for use; the power industry as an economic factor; the location of plants; the equipment of plants; mastering materials; mastering maintenance; mastering labor problems (conditions and compensations); mastering processes; mastering records; the analysis of expenses; power as a commodity.

Along with the ever-present philosophy of the subject is a large amount of valuable information and many practical suggestions based on the authors extensive engineering experience. The book is particularly rich in material dealing with the efficient operation of boiler rooms.

Steel Mill Buildings. By Milo S. Ketchum, University of Pennsylvania. Published by the McGraw-Hill Book Co., Inc., 370 Seventh Ave., New York City. Flexible binding, 6 x 9 in.; 632 pages, Price, $6.

To give a short course in the calculation of stresses in framed structures and to give a brief discussion of mill-building construction, this fourth edition is published as a supplement to elementary books on stresses on the one hand and to highly technical treatises on bridge design on the other. It is rewritten and enlarged from the first edition, which was published in 1903. It is in three parts, "Stresses in Framed Structures," "Deflections of Structures and Stresses in Statically Indeterminate Structures," and "Design of Steel Mill Buildings."

Obituary

Herbert Self, for many years a member of the "Engineers' Bunch" of entertainers, and salesman for the United States Rubber Co., died suddenly at Brooklyn, N. Y., on Jan. 26. He was 48 years of age, a member of the National Association of Stationary Engineers, a Mason and an Elk. In former years he was a familiar figure at the National and state conventions of the various engineers' associations.

Personals

M. D. Morley has been appointed far Eastern sales and engineering representative of the Combustion Engineering Corporation, and is now located in Manila, P. I.

Lyle A. Whitsit is now with the Adirondack Light and Power Corporation, Amsterdam, N. Y., as hydro-electric engineer. He was an engineer with the Superpower Survey.

Frank J. Beavers, formerly distribution engineer with the Gary Heat, Light and Water Co., Gary, Ind., is now with the engineering department of the Scranton Electric Co., Scranton, Pennsylvania.

F. D. Emory is now superintendent of operation and maintenance with the B. C. & Alberta Power Co., Ltd., Fernie, B. C., Canada. He was previously district inspector in the electricity and gas departments, Nelson, B. C.

Eric A. Lof, industrial engineer and specialist of the power and mining engineering department of the G. E. company, recently had a medal conferred on him by the King of Sweden, in recognition of meritorious services to the Swedish government.

Louis Illmer, of Lansdowne, Pa., who has been engaged in marketing a patented impulsion fuel pump for directly injecting liquid fuels into high-compression oil engines without compressed air, has been retained by the Brown-Ferrier Co., of Philadelphia, as consulting engineer in connection with the further development of such fuel-pump work.

Society Affairs

Coming Conventions

American Institute of Electrical Engineers—Midwinter convention at New York City, Feb. 15-17. Secy., F. L. Hutchinson, 29 West 39th St., New York City.

American Society of Mechanical Engineers — Spring meeting at Atlanta, Ga., May 8-11. Secy., Calvin W. Rice, 29 West 39th St., New York City.

National Electric Light Association —Annual convention at Atlantic City, N. J., May 15-20. Headquarters, 29 West 39th St., New York City.

Erie Section, A.I.E.E., will meet Feb. 21 for a motion picture and address on "Safety Engineering."

Schenectady Section, A.I.E.E., will meet Feb. 17 to hear L. T. Robinson, of the G. E. Co., speak on "Magnetism."

Cleveland Section, A.I.E.E., will meet Feb. 21 for an address on "The Superpower System," by W. S. Murray, who had charge of the survey.

San Francisco Section, A.I.E.E., is to meet Feb. 24 for a paper on "Electric Ship Propulsion."

Atlanta Section, A.I.E.E., will hear a talk on "Bloom Mill Electrification," Feb. 23, by S. N. Roberts, of the Atlantic Steel Co.

Metropolitan Section, A.S.M.E., will hold a joint meeting with the A.I.E.E. Feb. 24, in New York City, to discuss "Central Power Station Operation."

San Francisco Section, A.S.M.E., will meet Feb. 23 for addresses on "The Fuel Problem of the Pacific Coast" (by Charles H. Delaney), "Railway Fuel Problems," and "The Marine Fuel Problem."

Philadelphia Sections of the A.S.M.E., A.I.E.E., etc., and the Philadelphia Engineers' Club, will hold a Textile Symposium Feb. 28. There will be inspection trips in the morning and in the afternoon a technical session in the auditorium of the Chamber of Commerce. Among the papers will be one by Leo Loeb, of Day & Zimmerman, on "Problems and Economies of Textile Power Plants." There will be a dinner and evening session.

Business Items

The George J. Hagan Co., Pittsburgh, no longer represents the Combustion Engineering Corporation, but retains the exclusive agency for the type "H" stoker for use in Hagan industrial furnaces.

The Dominion Asbestos and Rubber Corporation has moved its executive offices from 154 Nassau St. to larger quarters at 1780-82 Broadway, New York City. The store and shipping office at 67 Murray St. will remain at the same address.

The Dayton-Dowd Co., Quincy, Ill., manufacturer of centrifugal pumps, has established a new district office in Pittsburgh in the Keenan Building. T. J. Barry, who has been with the home office for several years on engineering and sales, will be in charge.

The McClave-Brooks Co. has appointed K. S. Holmes, Jr., as its Cincinnati representative, with offices in the Gwynne Building, has transferred A. R. St. John from the Boston to the New York office, and has changed its branch office from Charlotte, N. C., to Greenville, S. C.

The Chillingworth Engineering Corporation, 143 Liberty St., New York City, has announced the association with it of Frank H. Plum, Herbert Pluemer, George E. Mellin and Harold von Thaden for the purpose of carrying on a business similar to that conducted by the C. W. Hunt Engineering Corporation, with the latter's consent and approval.

The Rathbun-Jones Engineering Co., Toledo, Ohio, has appointed the Ingersoll-Rand Co. general sales agent for Rathbun gas engines. It is pointed out that not only has the latter company a large sales organization and service department, but also that its product of compressors, pumps and other machinery is often installed with gas-engine drive.

Trade Catalogs

Dynamometers — Sprague Electric Works of General Electric Co., 527 West 34th St., New York City. Bulletin No. 48716, on electric dynamometers ranging in capacity from 2 to 500 hp., which can be supplied for speeds up to 4,000 r.p.m.

Fuses, Electrical Fittings, etc.— Chicago Fuse Manufacturing Co., Laflin and 13th Sts., Chicago. Catalog No. 29, 96 pages, 445 illustrations. A comprehensive, illustrated list of specifications and prices for fuses, board fittings, switch-boxes, etc.

Babbitting Motor Bearings—Westinghouse Electric and Manufacturing Co., East Pittsburgh, Penn. A reprint from *Aera* for August, 1921, by U. S. Dean, of the railway motor engineering department of the Westinghouse company. It covers in detail the selection and preparation of babbitt metal, and proper methods of pouring.

Coal- and Ash-Handling Machinery—Jeffrey Manufacturing Co., Columbus, Ohio. Bulletin No. 360 and Catalog No. 345. The bulletin covers briefly the Jeffrey portable car unloader for unloading coal from the hopper-bottom or gondola type of railroad cars, while the catalog describes twelve different types of equipment for handling coal and ashes in various sizes of power plants. The company makes conveyors of the bucket, spiral, belt, scraper and many other types, as well as coal crushers and other equipment of a similar nature.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine-run bases, f.o.b. mines):

Coal	Market Quoting	Jan. 30, 1922	Feb. 6, 1922
Pool 1,	New York	$2.85	$2.75@3.00
Pocahontas,	Columbus	2.15	2.00@2.30
Clearfield,	Boston	1.95	1.65@2.25
Somerset,	Boston	1.90	1.75@2.00
Pittsburgh,	Pittsburgh	2.15	2.10@2.20
Kanawha,	Columbus	1.65	1.50@1.80
Hocking,	Columbus	1.90	1.65@1.90
Pittsburgh No. 8	Cleveland	2.00	2.00
Franklin, Ill.,	Chicago	2.35	2.25@2.50
Central, Ill.,	Chicago	2.35	2.25@2.50
Ind. 4th Vein,	Chicago	2.40	2.35@2.65
Standard,	St. Louis	2.00	1.85@2.00
West Ky.,	Louisville	1.90	1.60@2.25
Big Seam,	Birmingham	1.85	1.75@2.00
S. E. Ky.,	Louisville	1.45	1.35@1.50

New York—On Feb. 8, Port Arthur light oil 22@25 deg. Baumé 4⅛c. per gal. 30@35 deg., 5½c. per gal., f.o.b. Bayonne, N. J.

Chicago—Feb. 3, for 24@28 deg. Baumé, 85@90c. per bbl.; 32@36 deg., 2⅜@2½c. per gal. in tank cars f.o.b. Oklahoma refinery, or freight adjusted.

Pittsburgh—On Jan. 31, f.o.b. refinery, Pennsylvania, 36@40 deg., 3¾@4c. Oklahoma 24@30 deg., 75@80c. per bbl.; gas oil, 32@34 deg., 2¾c. per gal.; 36@38 deg., 3c., 38@40 deg., 3¼c. per gal.

St. Louis—Feb. 4, prices f.o.b. cars, tank lots; 24@26 deg. Baumé, 75c. per bbl.; 26@28 deg., 85c.; 28@30 deg., 95c.; 32@34 deg., 2½c. per gal.

Philadelphia—On Feb. 6, 26@28 deg. Baumé, Oklahoma, 75@80c. per bbl.; 30@34 deg., Oklahoma (group 3) 2½@2⅝c. per gal; 16@20 deg., Seaboard, $1.15@$1.25 per bbl.

Cincinnati—Feb. 6, for 26@30 deg. Baumé, 4c.; Diesel 32@34 deg., 4⅛c. per gal.; distillate 38@46 deg., 5¼c. per gal.

Cleveland — Feb. 6, 26@30 deg. Baumé, 3c. per gal.

New Plant Construction

PROPOSED WORK

Ala., Fairhope—The Farmers Co-operative & Creamery Co., E. C. Rockwell, Secy. and Treas., is in the market for deep well pumps, 90 or 100 ft. deep to water.

Cal., Fresno—Radin & Kamp, 1935 Tulare St., have had preliminary plans prepared for a department store. About $1,000,000. Architect not announced.

Cal., Reedley—The Reedley Joint High School Dist. is having plans prepared and soon receives bids for a group of buildings. About $450,000. N. F. Marsh, Broadway Central Bldg., Los Angeles, Archt. Noted Feb. 8.

Cal., San Diego—The Bureau of Yards and Docks, Navy Dept., Wash, D. C., received bids for a refrigerating and cold storage plant from the Wittenmeier Mchy. Co., 850 North Spalding Ave., Chicago, Ill., $29,970; Amer. Carbonic Mchy. Co., 700 High St., Wisconsin Rapids, Wis., $30,400; and the York California Constr. Co., 308 Boyd St., Los Angeles, $45,000. Noted Jan. 24. Spec. 4543.

Cal., San Francisco—The City and county will receive bids in March for a 2 story, school (Horace Mann School) on 22nd and Valencia Sts. About $400,000. J. Reid, Jr., City Hall, Archt. Noted Dec. 13.

Cal., San Francisco—The El Francisco Corp., c/o M. V. B. McAdam Co., 58 Sutter St., is having plans prepared for an 8 story apartment on Mason and Sacramento Sts. About $1,000,000. M. Marcussen, Amer. Natl. Bank Bldg., Mgr. H. P. Merritt, 485 California St., Archt.

Conn., East Hartford—The Amer. Sumatra Tobacco Co., is in the market for two 35 to 40 hp. horizontal steam boilers.

Conn., New Haven—D. E. Smith, Archt., 152 Temple St., is receiving bids for a 1 story, 160 x 200 ft. factory including a 1 story, 40 x 50 ft. boiler plant on Arlington Ave. About $100,000. Owner's name withheld.

Fla., Crescent City—The city voted $12,000 bonds for a 100 hp. unit addition to electric light plant and $27,500 for installing water works. G. A. Main, Daytona, Engr.

Ia., Davenport—The city, S. R. Murray, Comr. Pub. Wks., will receive bids until Feb. 28 for a sewerage system and pumping station for the Duck Creek district. About $211,000. R. Earle, City Engr.

Ia., Des Moines—The Bd. Educ., G. Garton, Secy., received bids for a 3 story high school including a steam heating system from J. C. Mardis Co., SW. 21st and Section Sts., $865,365; W. F. Kucharo, 622 Hubbell Bldg., $896,000, and Fleisher Constr. Co., 608 Bldrs. Exchange Bldg., Minneapolis, Minn., $900,000.

Ia., Manning—The city is having plans prepared for a well and pumping plant. K. C. Gaynor Co., 525 Trimble Bldg., Sioux City, Engr.

Ia., Muscatine—The city, G. C. Park, Clk., plans improvements to waterworks including the installation of 16-20 in. main, from pump house on Island to Grandview Ave., also new pumps. About $50,000. J. Selden, City Engr.

Ia., Rutland—The Union Utilities Co., is having plans prepared for a power plant and dam. About $150,000. Toltz, King, & Day, 1410 Pioneer Bldg., St. Paul Minn., Engrs.

Ill., Astoria—The city is having plans prepared for pumping station and equipment, laying 4 and 6 in. cast iron water mains. About $50,000. Fuller & Beard, Railway Exchange Bldg., St. Louis, Mo., Engrs.

Ill., Chicago — The Bryin Mawr Beach Hotel Co., c/o Marshall & Fox, Archts., 721 North Michigan Ave., has had sketches made for a 20 story, 200 x 200 ft. hotel including a steam heating system on Sheridan Rd., Catalpa and Bryn Mawr Aves. About $5,000,000.

Ill., Chicago—A. Lynne, c/o the Great Western Smelting & Refining Co., 600 West 41st St., plans to build a 22 story, 90 x 106 ft. hotel including a steam heating system on Market and Madison Sts. About $3,000,000. Architect not selected.

Ill., Chicago—N. Shefner, c/o A. M. Ruttenberg, Archt., 105 North Clark St., is having plans prepared for a 3 story, 100 x 123 ft. apartment and store building including a steam heating system on Newgard and Devon Aves. About $250,000.

Ill., Fairburg—The city, W. Foster, Mayor, plans electric light plant. About $50,000. Architect not selected.

Ill., Rockford—The Chicago Grain Products Co., 1602 South Main St., is having plans prepared for a 1 story, 50 x 56 ft. power plant. About $30,000. W. J. Van Der Meir, 214 Mead Bldg., Engr.

Ill., Western Springs—The village Council is having plans prepared for a pumping station and laying 4 and 6 in. cast iron water mains. About $25,000. E. Hancock, 2047 Ogden Ave., Chicago, Engr.

Kan., Topeka—The Topeka Hotel Co. plans to build a 10 story hotel. About $600,000. O. B. Gufler, 919 Harrison St., Pres. Architect not selected.

La., New Orleans—The Valley Ice Co. c/o W. H. McGraw, Central Ice Co., 1121 Julia St., plans to build an ice plant (100 tons capacity) on Rocheblave and Republic Sts. About $30,000. C. A. Vitter, 1125 Julia Sts., Purch. Agt. Modern machinery will be installed.

Mass., Greenfield—The town of Greenfield, H. Richardson, Chn., Bldg. Comn., will receive bids until Feb. 18 for a 2 story, 225 x 255 ft. high school including a steam heating system on Federal and Sanderson Sts. About $500,000. L. C. Paton, 579 5th Ave., New York, and D. Blair, 154 East 61st St., New York, Archts.

Me., Millinocket—The Bd. Educ. is having plans prepared for a 2 story, 201 x 233 ft. high school. About $450,000. H. C. Coombs, 11 Lisbon St., Lewiston, Archt.

Md., Baltimore — The Embassador Theatre Co. plans to build a theatre on Charles St. near North Ave. About $1,000,000. E. G. Blanke, 532 North Calvert St., Archt.

Mich., Farmington—The Michigan Hospital School, 506 Congress Bldg., Detroit, is having plans prepared for a 3 story hospital school including a steam heating and ventilating system on Grand River Ave. About $250,000. A. Kahn, Marquette Bldg., Detroit, Archt.

Minn., Cloquet—The Northwestern Paper Co. C. I. McNair, Mgr., is having plans prepared for a 3 story sulphite pulp mill, including a steam heating system. About $500,000. G. F. Hardy, 309 Bway, New York City, Archt. and Engr.

Minn., St. Paul—The Bd. Educ., L. R. S. Ferguson, Comr., City Hall, is having plans prepared for a 2 story school including a steam heating system on 10th and Bway. About $340,000. C. A. Hausler, City Hall, Archt.

Mo., Cape Girardeau—H. L. Albert, c/o Chamber of Commerce, representing stock company, plans to build an 8 story hotel including a steam heating system. About $700,000. Architect not selected.

Mo., Webb City—The Webb City Stone Co., 20 South Main St., is in the market for an 18 or 20 in. stone crusher, one 50 hp. electric motor.

Miss., Gulfport—The Mississippi Cane Syrup Co., A. L. Byrd, Purch. Agt.—cold storage plant, capacity about 10 tons of ice per day.

N. J., Orange—The city is having preliminary plans prepared for an electrically operated pumping plant in connection with trunk sewerage system. About $110,000. W. L. Hull, City Hall, Engr.

N. Y., Hornell—The Bd. Educ. will soon receive bids for a high school including a steam heating system. About $450,000. Tooker & Marsh, 101 Park Ave., New York City, Archts. and Engrs. Noted Mar. 22.

N. Y., New York—Friedman & White Realty Co., Inc., c/o H. L. Young, Archt., 353 West 42nd St., is having plans prepared for a 6 story, 115 x 125 ft. apartment at 853 Riverside Drive. About $350,000.

N. Y., Newburgh—D. C. Miller, 258 Bway, is in the market for an 80 to 100 hp. steam boiler with about 125 lbs. steam pressure. (used).

N. Y., Niagara Falls—The city, E. J. Fort, City Mgr., 251 2nd St., plans to build several schools. Total cost about $3,000,000. Associated Architects of Niagara Falls, Archts.

N. Y., Tonawanda—The city is having plans prepared for complete mechanical filtration plant of 8,000,000 gal. daily capacity to include low service pumping machinery. J. N. Chester, Union Bank Bldg., Pittsburgh, Pa., Engrs.

N. C. Hertford—The town, B. G. Koonce, Clk. has authorized bonds to be sold for a municipal light, water and ice plant. About $100,000.

N. C., Wilson—The town, T. A. Hinnant, Clk., has authorized a bond issue of $70,000 for a municipal light and power plant.

O., Cincinnati—The National Biscuit Co., 10th Ave. and 15th St., New York, plans to build a 7 story, 140 x 463 ft. factory and warehouse at 617 Hunt St., here. A. G. Zimmerman, 85 9th Ave., New York, Engr.

O., Cleveland—The Bd. Educ., East 6th St. and Rockwell Ave., will receive bids until Feb. 20 for motor platforms and steel walkways, and installation of motor units, wiring and equipment for the mechanical operation of rolling partitions and steel mullions.

O., Cleveland—The Western Reserve University, c/o W. S. Hayden, of Hayden, Miller & Co., Citizens Bldg., is having plans prepared for a 1, 2 and 5 story medical school, power house and animal building, on Cummington Rd. About $2,500,000. Coolidge & Shattuck, 122 Ames Bldg., Boston, Mass., Archts.

O., Columbus—The Y. M. C. A., South 3rd St., will soon award the contract for an 8 story, 187 x 187 ft. Y. M. C. A. building on West Long St. About $650,000. W. F. Shattuck, 19 East La Salle St., Chicago, Ill., Archt. Noted Feb. 1.

Okla., Atoka—The Public Service Co. of Oklahoma, 107 East 4th St., Tulsa, c/o J. McCrary, Treas., is having plans prepared for a 48 x 84 ft. ice plant. About $15,000. Private plans. Boilers, engines and ice machinery will be installed.

Okla., Gracemont—C. H. Hertzler is in the market for a 25 hp. engine.

Pa., Altoona—The Confederated Home Abattoir Co., F. Rider, Secy., 123 Willow Ave., has purchased a site on Eldorado Rd. near here and plans to build a 3 story, 100 x 130 ft. meat packing plant, including power and heating plant. About $150,000.

Pa., Greensburg—The Westmoreland Hospital is having plans prepared for an addition to hospital including a boiler house and laundry. About $500,000. E. L. Tilton, 52 Vanderbilt Ave., New York City, Archt., P. A. Bartholomew, Coulter Bldg., Assoc. Archt.

Pa., Phila.—The city will receive bids until Feb. 15 for a pumping station at Lower Roxbury Filter. About $25,000. C. E. Davis, City Hall, Engr.

R. I., Providence—Jenks & Ballou, Engrs., 10 Weybosset St., will receive bids about March 1 for a service station for the Narragansett Electric Lighting Co., Turks Head Bldg., including a 4 story, 42 x 154 ft. office building with 42 x 70 ft. wing, 3 story, 101 x 223 ft. light storage building and a 1 story, 120 x 223 ft. heavy storage building and a 1 and 2 story, 115 x 173 ft. garage, a 1 and 2 story, 45 x 56 ft. power plant, 1 story, 28 x 93 ft. oil house with 17 x 22 ft. ell, 2 story, 10 x 17 ft. gate house, two 10 ton traveling cranes and three 1 ton cranes, etc.

Tex., Kerrville—Phelps & Dewees, Archts., Gunter Bldg., San Antonia, will receive bids until March 6 for a refrigeration plant a sewerage disposal plant 190 x 33 ft. servents ward 40 x 90 ft. dormitory building on the American Legion site here, for the American Legion Board. Austin. About $150,000.

Va., Boone Mill—The Boone Mill Mfg. Co., J. Garet, Pres., is in the market for planing mill machinery, engine and boilers for woodworking plant, dry kiln equipment, etc. (used).

Va., Charlottesville—The city has had plans prepared for a power house, pumping station, reservoir, pipe lines, etc., on the Moorman River to complete the waterworks system. About $370,000. Williamson, Carrol & Saunders, Charlottesville, Engrs.

Va., Hampton Roads—The Bureau of Yards and Docks, Navy Dept., Washington, D. C., will receive bids until Feb. 15 for a motor generator set and switchboard, for the Naval Operating Base Hospital, here. Noted Jan. 10. Spec. 4570.

Va., Winchester—The George Washington Hotel Corp. plans to build a 5 story, 80 x 130 ft. hotel on Market and Piccadilly Sts. Cost between $300,000 and $400,000. Architect not selected.

Wis., Ellis Jct. (Crivitz P. O.)—The Wisconsin Public Service Co., 425 East Water St., Milwaukee, is having plans prepared for 2 hydro electric plants on Peshtigo River. First to be built to have 41 ft. head, 2600 hp. Total cost about $200,000. Mead & Seastone, State Journal Bldg., Madison, Engrs.

Wis., Madison—W. R. McNeil, Capitol Hotel, is receiving bids for an 8 story hotel including a steam heating system. About $750,000. W. W. Allsecklager, 65 East Huron St., Chicago, Ill., Archt.

Wis., Manitowoc—The Republic Chemical Co., E. H. Kochneke, Pres., is in the market for power plant equipment also machinery for new chemical plant and equipment for laboratory.

Wis., Peshtigo—The Oconto Service Co., F. Pamferer, Pres., is having plans prepared for an additional unit in power plant, including installation of 450 k.w. generator, switchboard, etc. About $50,000. Mead & Seastone, Madison, Engrs.

Ont., Bright—The council, G. Oliver, plans electric light and power distribution system. About $25,000. J. N. Wilson, 190 University Ave., Toronto, Engr.

Ont., Peterboro—The Bd. Pub. Wks. is having plans prepared for an activated sludge sewage disposal system, including air diffusers compressors, electric motor driven. About $50,000. R. H. Parsons, City Hall, Engr.

Ont., St. Thomas—The council, A. Curtis, Chn., is having plans prepared for improvement to civic gas plant including the installation of coal and coke handling equipment and reset boilers. About $175,000. W. V. Miller, City Hall, Engr.

Ont., St. Thomas—The Electrical Comn., plans to install additional transformers and equipment at the hydro station here. About $30,000. W. K. Sanderson, City Hall, Engr.

Ont., Windsor—The city plans to build a hospital including a steam heating system. About $600,000. Architect not selected.

CONTRACTS AWARDED

Ga., Augusta—The Treasury Dept. J. A Wetmore, Supervising Archt., Washington D. C., has awarded the contract for a United States Public Health Service Hospital here to the Northeastern Constr. Co., Charlotte, N. C., $263,000, and the mechanical equipment to Noland-Clifford Co., Inc., 330 28th St., Newport News, Va., $134,000. Noted Jan. 31.

Ia., Storm Lake—The city has awarded the contract for Sec. 1—250,000 gal. steel tank on 100 ft. tower to the Pittsburgh-Des Moines Steel Co., Tuttle and S. W. 10th Sts., Des Moines, $14,250; Sec. 2—two triplex pumps and one 40 hp. motor to J. F. Dlugasch, Storm Lake, $10,000; and one 37 hp. oil engine to Fairbanks-Morse Co., 900 South Wabash Ave., Chicago, Ill., $2,850. Noted Jan. 24.

Kan., Neodesha—The city has awarded the contract for two 300 K.W. full Diesel type oil engines to the Nordberg Mfg. Co., 410 Chicago and Oklahoma Sts., Milwaukee, Wis., $82,550. Noted Jan. 24.

Me., Portland—The Cumberland County Power & Light Co., has awarded the contract for a power plant, 10,000 K.W. 3 phase 60 cycle A.C., to the Foundation Co., 233 Bway., New York City. About $800,000. Noted Jan. 24.

Mich., Lansing—The City has awarded the general contract for a 150 x 260 ft. municipal power plant to F. H. Davis, 1838 Penobscot Bldg., Detroit, and the electrical equipment to Hatzel & Buehler, Inc., 373 4th Ave., New York City. Total cost about $1,000,000.

Mo., Moberly—The city c/o J. E. Curry, Clk., has awarded the contract for a pumping station, filtration plant, dam and reservoir to Lynch & McDonald, Moberly. Noted Feb. 7.

N. Y., Brooklyn—The Bd. Educ. has awarded the contract for a heating and ventilating system for P. S. 54 on Sandford St., between Willoughby and DeKalb Aves. to the Federal Heating Co., 300 Madison Ave., $80,400. Noted Feb. 7.

N. Y., Brooklyn—The Supt. Pub. Wks., Albany, has awarded the contract for Terminal Contract No. 115, installing of electric wiring, power and battery charging equipment in the canal terminal warehouse at Gowanus Bay, to the Croker Natl. Fire Extinguishing Engr. Co., 220 West 30th St., New York City, $42,460. Noted Nov. 29.

W. Va., Bluefield—The Bluefield Ice & Cold Storage Co. has awarded the contract for an ice plant on Bluefield Ave. and Poplar St., to the G. C. Bright Co., Marquette Bldg., Detroit, Mich. About $60,000.

Wis., Milwaukee—The Sewerage Comn. has awarded the contract for automatic return sludge pumping station on Jones Island to Allis Chalmers Mfg. Co., West Allis, $34,900; furnishing 4 sluice gates to Worthington Pump & Mchy. Corp., Worcester, Pa., $6,440; plug valves to the Chapman Valve Mfg. Co., Indian Harbor, Mass., $52,945.